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THE MAGAZINE OF APPLIED ENGINEERING

AUGUST 1955

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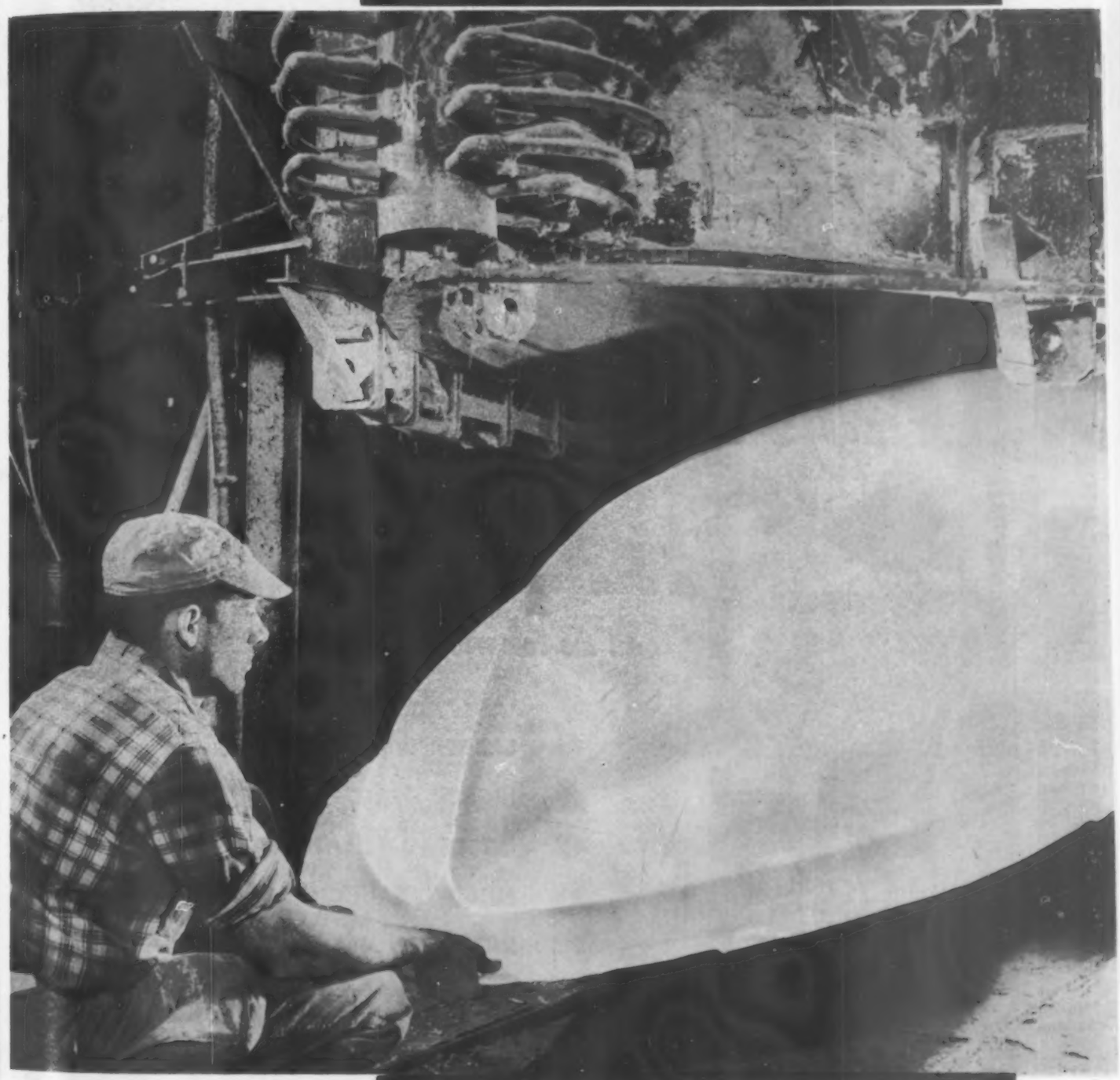

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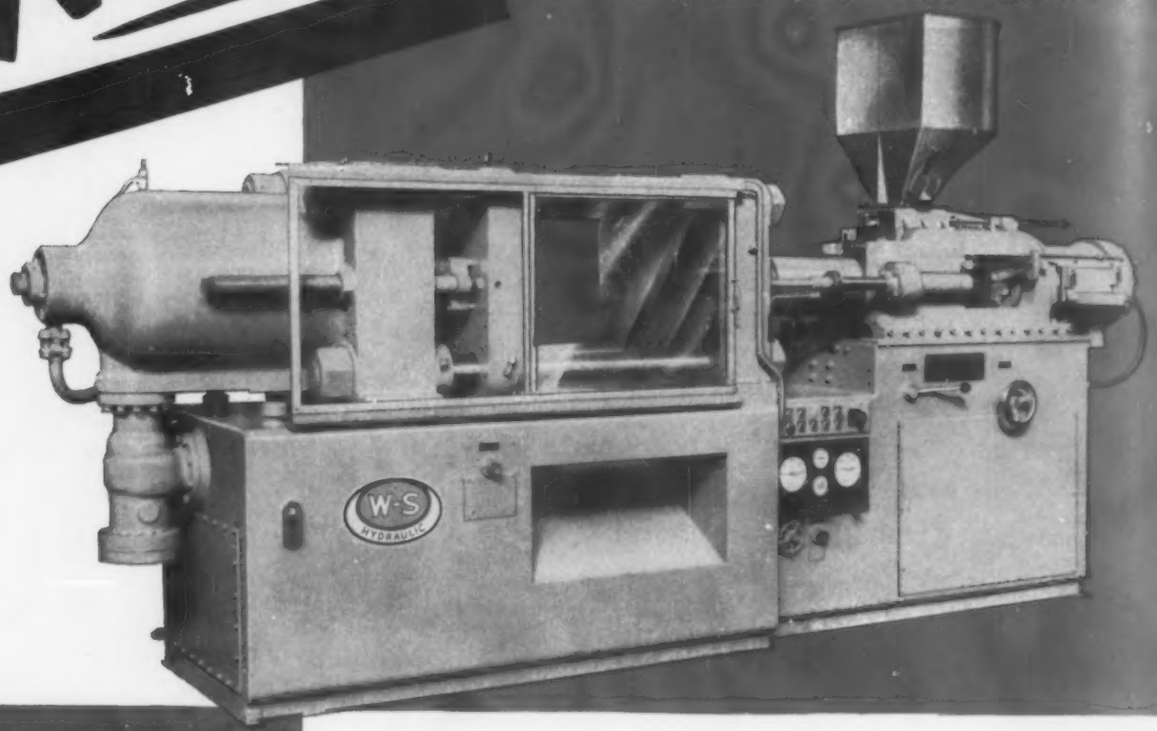

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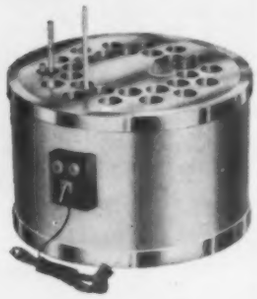

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Letters to the Editor

Dear Sir:

Control of temperature in the injection molding heating cylinder is, as A. R. Morse points out in his fine article (see June issue), a very important and too often neglected phase of molding technology. Most of his conclusions are sound; the article is a step forward in molding technology.

While the job of measuring internal temperatures is much simplified by using an empty cylinder, the lack of heat removal from those interior surfaces results in readings which cannot be representative of molding conditions. For instance, we have measured temperatures at the spreader tip of 150° F. less than the cylinder temperature. When heat is being removed from the spreader and supporting struts, the strut temperature can hardly be higher than that of the cylinder. The "jetting" phenomenon was observed with a torpedo whose supporting struts actually did not touch the cylinder wall.

The wattage of a set of electric heaters is a measure of their maximum available heat; no more. Just adding watt capacity to a cylinder does not increase the heat transferred to the plastic, any more than an automobile's power is increased by a bigger gas tank. Mr. Morse's cylinders do, apparently, have increased internal surface to absorb those extra watts, but he should be more specific on this point.

While the plasticizing performance of a heating cylinder can be improved by adding internal surface area, care should be exercised to keep the volume at a minimum. There are two reasons for this: First, the heat transfer rate to the plastic is a direct function of the thickness of the material (this goes for any material—a steak, for instance). For most heating chamber shapes, the output is dependent on the $(\text{Surface})^2/(\text{Volume})$ ratio.

Secondly, increased volume means increased inventory time at any given cycle. This increases the amount of plastic needed to purge the cylinder and worsens the problem of heat breakdown. Indeed, some plastics can be molded only by heating cylinders of very small volume.

Reference is made in the article to a recent publication by "Dow technicians" on the subject of heating chamber design. We presume the article in question is the one given by us at the recent SPE convention in January. The flange-mounted spreader, as used by IMS, HPM, Fellows, Peco, and formerly by Reed-Prentice, is a good, well proven design, but we never intended to designate it as "optimum," or even the best available today. Vast improvements in heating chamber performance are possible, but will be achieved through careful design incorporating a thorough understanding of plastic flow and heat transfer.

C. E. Beyer, R. B. McKee, and R. B. Dahl
Plastics Basic Research Lab.,
The Dow Chemical Company
Midland, Michigan

• • •

Dear Sir:

Is there an additive that can safely be introduced externally into commercial polystyrene in order to lower the injection molding temperature and increase the molding area while, at the same time, not have too great an effect on the original properties of the material? Any information that your readers can furnish will be appreciated.

(Identity withheld)

Dear Sir:

It may interest you to know that our engineering and sales personnel unanimously feel that PLASTICS TECHNOLOGY is a very long step forward, and it is of the greatest interest to all of them.

Mitchell A. Kapland, Vice Pres.
The Englander Company, Inc.
Baltimore, Maryland

• • •

Dear Sir:

We refer to your news items on page 374 of the July issue.

For the first time in 14 years, we missed the fact that there are other products with the similar name of Stabilite, and have been asked to correct our name. We are happy to do so, calling this destaticizing stabilizer Merix AST Concentrate 1001.

Would you plase cooperate and inform your readers of this correction in name?

E. O. Sonneman, General Manager
Merix Chemical Co., Chicago, Ill.

Dear Sir:

I have read the Letter to the Editor by Tung Tsang which appeared in the June issue, page 268. An error was committed by Mr. Tsang in his attempt to comment on the article "Recent Advances in Epoxy Resins" by Elliott N. Dorman (May issue, page 213). I find that Mr. Tsang's statement, "Aliphatic amines cure epoxy resins mainly by catalytic reaction. Aromatic amines cure epoxy resins mainly by addition reaction." is not essentially correct.

Inasmuch as little fundamental work has been conducted on the curing of epoxy resins, the mechanism of cure is not fully understood. However, recent evidence has indicated that some organic amines show signs of acting catalytically, while others combine in molar proportions with the epoxy resin to favor an addition mechanism. The type of curing process does not depend, as Mr. Tsang implied, on whether the organic amine is of the aliphatic or aromatic type, but rather depends on the presence of hydrogen on the nitrogen atom.

Work conducted by E. S. Narracott (*Brit. Plastics*, 26, 120 [1953]), and later substantiated and extended by Shechter, Wynstra, and Kurkjy (ACS Division of Paint, Plastics, and Printing Ink Chemistry meeting, 1955) infer that curing of epoxy resins with tertiary amines, such as triethylamine (aliphatic) or benzyl dimethylamine (aromatic), is effected catalytically by polymerization of epoxide groups. On the other hand, primary amines and secondary amines, either aliphatic or aromatic, react chemically by addition with the epoxy resin. Polyamines containing active hydrogen, such as diethylene triamine (aliphatic) or m-phenylene diamine (aromatic), react with the epoxy resin by addition to give a thermoset product.

Salvatore Stivala
Stevens Institute of Technology
Hoboken, New Jersey

• • •

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address. Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request the identities of such "problem" letters will not be divulged.
—The Editor

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Program for Profits

NEWS in BRIEF

Increased Navy use of plastics bolsters national defense and also saves taxpayer money. Applications include fuel tank coatings of vinylidene chloride-acrylonitrile copolymer; nylon electrical fittings; phenolic foams replacing balsa for filling blisters; plastic tanks for storing fresh water, oil, and bleach; and plastic piping.

Polyethylene developments during the month saw Dow Chemical's new Freeport, Tex., plant in full-scale operation. Injection molding and pipe extrusion grades are already available, and other formulations are under development. W. R. Grace has signed a license agreement with Phillips Petroleum to use the latter's polyethylene production method. Presently considering plant sites, Grace will begin construction of a plant next year and operation is expected early in 1957. The project will involve more than $18 million, raising Grace's capital investment in the chemical industry to over $150 million.

Rigid vinyl pipe as "house plumbing" is being evaluated in a model school building at Michigan University. Should the experiment prove successful, plastic pipe for all home plumbing needs could be a reality in the future.

The vast range of plastics technology available currently is only scratching the surface, and the day will come when this knowledge will be inadequate, according to H. R. Thies, of Goodyear Tire & Rubber Co. (see guest editorial, page 420). The plastics industry faces a challenge to raise its technology to a new level and, in so doing, create other new industries that will contribute to the American way of life.

Company expansions in plastics continue unabated. Bristol-Myers, the pharmaceutical firm, purchased Kimball Mfg., makers of molded reinforced plastics, which will operate as a wholly-owned subsidiary. A new chemical plant will be built by Celanese Corp. at Gallipolis Ferry, W. Va., to make plasticizers and other materials, with initial production expected next April. DeBell & Richardson has virtually doubled available floor space by the purchase of adjacent facilities. Emery Industries opened its new research center which houses laboratory, chemical engineering, and pilot plant facilities. A half-million dollar expansion at Panelyte Division, St. Regis Paper, will increase production of injection moldings by 40% and make vacuum forming a full scale commercial operation. A million-dollar expansion by Shawinigan Resins of its Springfield, Mass., PVA plant is scheduled for completion late next year. Overseas, Lunn Laminates has formed an Australian firm to make reinforced plastic automotive parts, and made reciprocity agreements with a New Zealand company. A British firm to make stabilizers, plasticizers, and other chemicals has been formed by National Lead.

Polyurethane foam system introduced by Surface Chemicals is suitable for coating surfaces and filling voids where isocyanate foams previously were impractical. The system employs premixed and metered resin and catalyst, gives foams of variable and controllable density, and eliminates the need for steam lines, molds, heat, and pressure.

New Materials in the news this month (see page 443): three vinyl stabilizers; a metal-adhesive vinyl plastisol; a chemical-resistant acrylate-type elastomer; a vinyl extrusion compound; a vinyl dispersion plasticizer (DOA); an anti-static plastics detergent; a vinyl plastisol for plating racks; vinyl wire and cable insulating compounds; and a methacrylate-type thermoplastic sheeting.

New Equipment of interest (see page 445): a high-shear viscometer; a hot-cold tensile tester for elastomers; an automatic two-station vacuum forming machine; thermoplastic heat regulator; and an automatic printer-packager.

New Products worthy of mention (see page 447): a polyethylene lunch box; vinyl insulation sleeving; a polyethylene sink trap; phenolic-overlaid plywood; polystyrene light diffusers; vinyl foam-lined jacket and vest; polyester-glass pipe, fittings, and valves; and all-vinyl handgrips.

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PLASTICS TECHNOLOGY

AUGUST, 1955

EDITORIAL: A National Plastics Institute is Proposed

Everyone concerned with the continuing development of the plastics industry recognizes and agrees with the need for accumulating and disseminating adequate engineering data on plastic materials. These data are badly needed for the expansion of plastics into the engineering applications that comprise the true potential for future growth. But how will these data be gathered, and by whom?

The obvious choice to conduct this work is the materials supplier, since he already is active in this endeavor. The question is should such work be expected of him? While the materials suppliers do conduct many engineering investigations, they are limited in scope essentially to their own materials which comprise their primary interests. In addition, suppliers are commercial firms and must be practical in allocating money, time, and manpower for this type of work.

•

A possible solution to the problem of who will gather the engineering data could be the establishment of a national plastics institute supported by all branches of the industry. Such an institute would not be bound to any one company or group of companies, but would be free to undertake a systematic program dealing with all plastic materials. The cooperative effort entailed in establishing the institute can be successful in view of the precedents existing in the testing programs being conducted at MIT, Battelle, and others.

The proposed institute could well have a two-fold objective: (1) a general program aimed at obtaining engineering data on all plastic materials; and (2) application-type studies on specific plastic problems. Incidentally, this application program could serve to combine under one agency the existing investigations, such as that on plastic pipe, now being parcelled out to different institutions. Going even further, we could add a third objective; that of conducting basic or fundamental work on plastics, such as studies of the polymerization reaction, and the like.

As previously stated, the proposed institute should be supported by the entire domestic plastics industry, not by just a segment.

•

It is not our intention at this time to bring forth specific proposals dealing with the support mechanism for the institute, its organization, financial structure, and the many other details that would be involved in translating the proposal into an actuality.

Rather, we invite comments from all members of the industry on the need for the proposed institute, how it should operate, its objectives, and what it can be expected to accomplish. This is a matter affecting the entire industry, and we are anxious to obtain your thoughts, whether pro or con.

Arthur M. Merrill

Editor

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Earl Ziegler received a B.S. in Mechanical Engineering from Wayne University in 1936. He was with General Motors Truck Co. from 1936-1940; Standard Oil Co. of Ind. from 1940-1943; and has served with Dow since 1943. Mr. Ziegler is active in Plastic Wall Tile Standards at the Bureau of Standards and the SPI. He holds membership in ASTM, SPI, ISO, and the Midland Engineering Society.

William Brown was graduated from the State University of New York in 1951, with a B.S. in Pulp & Paper Manufacture. Since joining Dow in 1951, he has been concerned with plastics testing and has served with several industry standards and specifications committees. Mr. Brown is a member of the ACS, ASTM, SPI, and the Midland Engineering Society.

Stress Cracking (Crazing) of Polystyrene—Part II

The conclusion of a two-part article describing a new test for critical stress showing why some applications of polystyrene are unsatisfactory, and indicating remedies based on proper design and molding.

E. E. ZIEGLER *and* W. E. BROWN

Plastics Technical Service, Dow Chemical Co., Midland, Mich.

Of considerable importance from the practical standpoint is the stress cracking of polystyrene in a variety of reagents. Many hypotheses have been offered to explain this. Actually, the precise mechanism whereby chemical reagents cause stress cracks to originate and grow is not well understood.

It is possible that the effect depends upon absorption of the reagent by the surface layers of the polystyrene. The reagent may then act as a plasticizer, further entering the polystyrene molding and reducing the attractive forces between the chains so that they may be pulled apart (1) or slipped against each other more readily.

Regardless of the precise mechanism, the stress cracking pattern of an actual molding would be expected to differ from that obtained on a test specimen stressed in pure tension. Instead of forming a regular system of parallel cracks at right angles to the applied stress, stress cracking might be expected to follow a pattern indicating the localized combinations of highest internal and applied stress with lowest internal strength.

Thus, stress cracks might be expected to develop along flow and weld lines in injection molded articles by virtue of some internal stresses being present at right angles to the direction of plastic flow. This can be accelerated and aggravated by the application of certain reagents, either in handling, finishing, or actually using the finished moldings. Of course, it can also be accomplished by deliberately immersing the moldings in various liquid reagents.

For example, highly internally stressed wall tiles subjected to chemical action by a particular mastic or solvent type "cleaner" will develop stress cracks along the lines of plastic flow emanating from the gate. These cracks progress across the flat face of the tile, as well as around the edges where the internal stresses are high. Drinking tumblers used with milk or hot beverages for

some period of time develop cracks along their flow lines, starting with radial cracks from the gate and progressing across the bottom of the tumbler and up the side walls. Back painted moldings in contact with lacquer solvents for a relatively brief period of time develop cracks along their flow lines if the combination of internal stress intensity, orientation, and lowered critical stress is such as to produce stress cracking.

The bending form test, utilizing practically stress-free compression moldings, is particularly useful in determining relatively quickly and easily to what extent polystyrene's critical stress is lowered in contact with various reagents. By the proper use of knowledge thus gained, it is possible to determine the actual internal stress in a molding. It is possible to determine accurately the benefits derived from annealing stressed moldings. It is also possible to predict the effect of external loads, contact reagents, and use conditions on the stress cracking tendencies of various moldings. This knowledge can be used to design and mold better plastic parts.

It will be remembered from Figure 3 that the minimum equilibrium critical stress of polystyrene in air (or water) at room temperature is 1,500 psi., and is not reached until about 50 hours of stressing time have been completed. Thereafter, no further loss in critical stress would be expected.

As shown in Figure 5, the time-crazing effects of other reagents on polystyrene vary widely, depending upon the nature of the reagent. Propylene glycol, for instance, takes at least 150 hours to reduce polystyrene's critical stress to a minimum equilibrium of about 800 psi. This information is useful in explaining why some moldings craze when immersed in propylene glycol for the determination of heat distortion temperature or for purposes of annealing. It should be borne in mind that these values of allowable stress would be depressed still further upon immersion at temperatures well above 75° F.

Methanol is very fast acting and requires only a few minutes on the stressed area to reduce polystyrene's equilibrium critical stress to 1,000 psi. Fingerprints on a stressed surface result in a depression of critical stress to 1,600 psi. in 30 seconds and, in some cases, down to 500 psi. in long-time tests.

KEROSENE. The use of kerosene for the determination of stress level in molded polystyrene parts has been

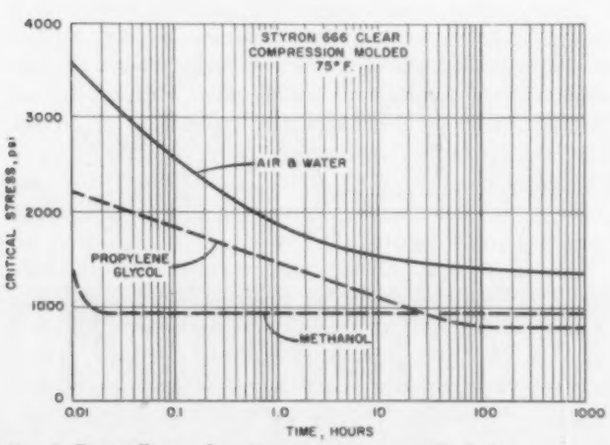

Fig. 5. Time effects of various reagents on critical stress.

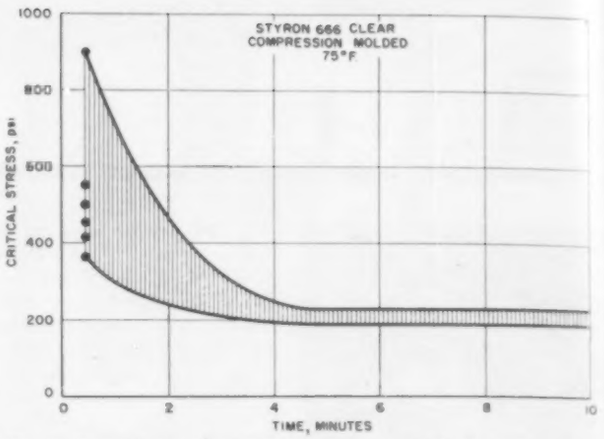

Fig. 6. Time effects of various kerosenes on critical stress.

debated for years. There are some who believe such a test to be valuable, while others disagree. In order to determine accurately the effect of such liquids on polystyrene's critical stress, samples of high and low grade kerosene obtained from various sources were used in bending form tests.

"Instantaneous" values of critical stress varied widely, as shown in Figure 6, apparently substantiating those who object to the use of kerosene because, first, it is not a chemical entity, secondly, no two kerosenes are exactly alike, and results of kerosene on polystyrene's stress cracking tendencies can be neither trusted nor reproduced.

Equilibrium values of critical stress showed an appreciable narrowing of this range, actually down to the point where the use of kerosene for crazing tests can be justified if the time interval of testing is of sufficient duration, and if range oil, heater oil, or distillate are not substituted for kerosene. Results over a period of time showed that polystyrene moldings stressed above 200 psi. would craze in contact with kerosenes.

NORMAL HEPTANE. There has been rather wide acceptance of normal heptane as a "cure-all" immersion test for polystyrene moldings. Proponents of its use have immersed moldings weighing from a few ounces up to several pounds in normal heptane at or near room temperature for times varying between a few seconds and 30 minutes, in most cases without knowledge of the exact effect of such immersion.

Figure 7 shows the effect of pure normal heptane on

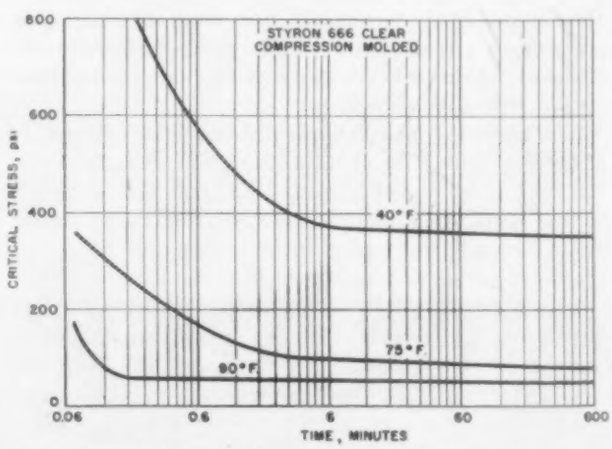

Fig. 7. Effect of normal heptane on critical stress.

polystyrene at three temperatures. It will be noted that temperature and time of immersion are variables of considerable importance. Furthermore, normal heptane is very effective in lowering polystyrene's critical stress; so effective that stresses above 50 psi. will cause stress cracking at 90° F.

Laboratory tests have proven that normal heptane, once applied to a polystyrene surface, is not easily removed. Evaporation soon removes the surface excess, but penetration of a small portion into the molding continues to depress the critical stress long after actual immersion has stopped. It is known that normal heptane is still retained internally in a molding after one week's drying time at 75° F. and 50% relative humidity. Substantiating data are shown in Table 8.

In our opinion, testing polystyrene parts in normal heptane should be undertaken only after the operational details and significance of the test are thoroughly understood and, preferably, only after correlation with actual end-use has been established. Otherwise, more harm than good may result.

DAIRY PRODUCTS. It will be noted from Table 4 that dairy products lower polystyrene's resistance to stress cracking in varying degrees, dependent to some extent on the butterfat content. Skim milk, containing only traces of butterfat, lowers the critical stress of Styron 666 to 750 psi. at equilibrium. Butter depresses the stress cracking resistance to 450 psi. Homogenized milk and cream behave in the same way. Butterfat obviously weakens polystyrene, and is undoubtedly the cause of the relatively short life of average polystyrene tumblers used regularly with milk products.

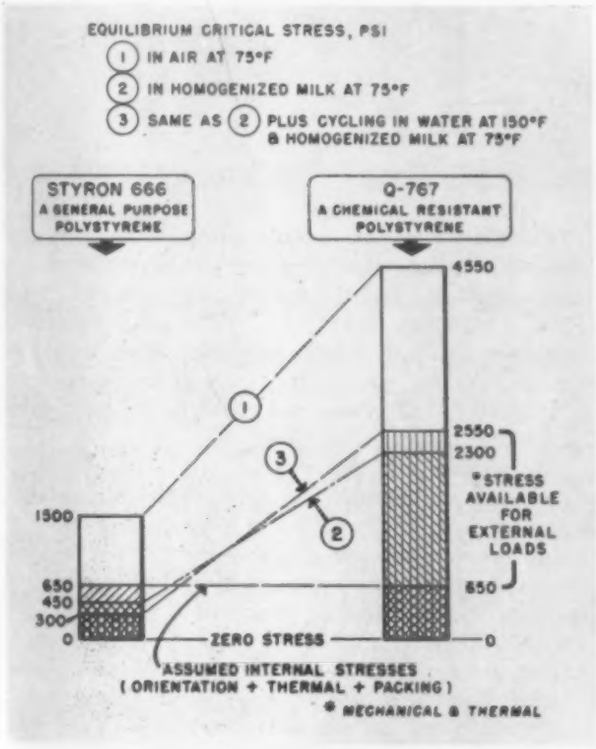

Fig. 8. Comparative stress cracking of tumblers molded of general-purpose and chemical-resistant polystyrenes.

In actual use, some thermal stresses are set up in a polystyrene tumbler as cold milk is poured into it. At low temperature, the damaging effect of the fat is less severe, but as the temperature rises the effect becomes more pronounced. Reference to Table 4 shows that if the stress on tumblers used for some time with milk were more than 450-600 psi. at 75° F., stress cracking would result.

In normal use, a thin layer of milk (and fat) remains on the inside walls of a tumbler when it is submerged in hot dishwater. At a temperature of 125° F., the critical stress is still further depressed to a level of about 300 psi. In scalding rinse water, a stress of about 200 psi. would be sufficient to initiate crazing and a good portion of this could be created by the thermal shock of the hot rinse itself, leaving very little allowance for internal molding stresses or mechanical loading stresses resulting from stacking, rough handling, or accidental dropping.

Table 4. Effect of Dairy Products on Stress Cracking of Styron 666 and Q-767 at 75° F.

	Equilibrium Critical Stress, Psi.	
Reagent	Styron 666	Q-767
Air	1,500	4,550
Water	1,500	3,600
Evaporated milk	900	4,100
Skim milk	750	2,300
Homogenized milk	450	2,300
Cream	450	2,100
Butter	450	2,100

It would be natural to assume that the deleterious effect of milk or cream would be limited to the time of actual contact and that, once washed, the process would naturally start over from the beginning. Unfortunately, this is not the case, and the effect of such contact, intermittent or continuous, is cumulative. The critical stress of a polystyrene molding has been shown to be the same whether it is immersed in milk or cream in stressed condition for a given time interval, or immersed in totally unstressed conditions, washed in soapy water, dried for 24 hours, and then stressed for the same time interval.

Apparently there is some penetration into the polystyrene even by relatively viscous fats and oils which makes removal by surface washing a practical impossibility. This penetration, and its cumulative effect in depressing polystyrene's critical stress, explains why tumblers may be used with milk for weeks or months without visible evidence of damage and then, under the same use conditions, start to stress crack and even crack open in complete failure.

In our attempt to evaluate polystyrene tumblers and help molders improve the quality of their products, the serious problem arose of devising new laboratory tests which would correlate with actual use. It was not until an eight-month use test on several types of plastic tumblers was conducted among 750 families (statistically balanced by nationwide Census figures), and elaborate questionnaires were returned and summarized, that such

a correlation became possible. We are able now to determine in a few minutes by specialized laboratory tests whether any polystyrene tumbler is up to what this nationwide poll rated as an acceptable standard of quality.

The effects of dairy products on polystyrene tumblers emphasize the great importance attached to the design and molding of polystyrene in order to maintain minimum internal stress. A second solution to the problem of obtaining acceptable quality involves a change of materials from general-purpose polystyrene to a chemical-resistant formulation with high heat distortion, such as Dow's Q-767. Under identical conditions of contact with dairy products, Q-767 exhibits three to five times the critical stress of general-purpose polystyrene.

Figure 8 compares these two materials tested on bending forms in simulated home use. Step 1 shows that general-purpose Styron 666 has only one-third the critical stress of Q-767 in air at 75° F. Assuming that tumblers molded from each material contain the realistic level of 650 psi. internal stress, it is easily seen that the general-purpose material suffers more by the presence of internal stresses because the reduction in usable stress represents a much larger percentage of the critical stress than with Q-767.

Step 2 of Figure 8 illustrates what frequently happens when homogenized milk is poured into a polystyrene tumbler, even in the absence of such adverse effects as external mechanical loads and temperature increases. The critical stress in this case has already dropped below the internal stresses present as a result of design considerations and conditions of manufacture. The tumbler will eventually stress crack when the homogenized milk has entered into the areas of internal stress, and will stress crack even sooner if external mechanical loads and thermal shocks are suffered by the molding.

These conditions are badly aggravated upon cycling the tumbler in water at 150° F. and homogenized milk at room temperature, as shown in Step 3 of Figure 8. The minimum equilibrium critical stress in this case becomes only 300 psi. with Styron 666. On the other hand, Q-767 tumblers maintain a major amount of critical stress which is usable over and above the internal stresses present in the moldings.

A further advantage offered by Q-767 is that it responds to cycling in water and milk in such a way that the effect of the milk is somewhat alleviated. Homogenized milk lowered the critical stress to 2,300 psi., whereas cycling in water at 150° F. (which amounts to simulated dish washing) and milk at 75° F. increased the critical stress by 250 psi. to a level 1,900 psi. above the internal stress. Thus, a greater amount of usable stress may be obtained from a Q-767 molding after passing through the described cycles (even in the presence of high internal stress) than can be obtained from a stress-free general-purpose polystyrene molding of the same design.

HAIR PREPARATIONS AND OILS. Conflicting reports were received from the field not long ago concerning the failure of polystyrene hair curlers in actual use. The failures, always associated with stress cracking of the curlers after extensive use, were attributed to insufficient impact and flexural strengths, inadequate heat distortion, excessive molding stresses, and off-grade raw material.

Our investigation of the effect on polystyrene's critical stress of the various hair preparations used in beauty parlors led to the conclusion that these creams and liquids were relatively harmless as far as polystyrene was concerned. It was then discovered that natural hair oil lowered polystyrene's critical stress much more severely than any of the prepared lotions, and that the damage was equally as severe immediately after washing the hair as before washing. Typical data are given in Table 5.

Table 5. Effect of Hair Lotions on Styron 666 at 75° F.

Reagent	Critical Stress, % (after 20 minutes)
Air or water	2,150
Cold Wave: Type A	2,000
Type B	1,950
Type C	1,650
Cream Fixative	1,550
Powdered bleach solution	1,500
Lanolin wave	1,750
Natural hair oil	700
Sebum (surface skin fat)	800

Table 6. Effect of Wall Tile Cleaners on Styron 666 at 75° F.

Cleaner	Critical Stress, % (after 30 secs.)
Air or water	3,500
Type #1	1,550
#2	1,250
#3	1,150
#4	950
#5	700
#6	700
#7	250

The difficulty was made more serious by the fact that considerable mechanical stress was placed on the curlers during actual use, and the temperature instead of being 75° F. was as high as 185° F. Solution of the problem came from a change of materials, not to high impact or high heat types, but to the Dow chemical-resistant formulation Q-767 which had three times the critical stress under identical conditions.

It is obvious that polystyrene combs in prolonged contact with hair oil suffer the same effects over a period of time, and can finally withstand a tensile stress of only 700 psi. or less. Substitution of Q-767 for any regular polystyrene should result in much improved combs with greatly extended craze-free service life.

WALL TILE CLEANERS. Complaints have been received from the field at various times stating that mounted plastic wall tiles were developing cracks under certain conditions. On one occasion, it was shown that the tile design was such that internal stresses of serious magnitude were responsible for the difficulty. On another occasion, it was shown that the high molding

stresses incorporated in the tile could be relieved by annealing, so that stress cracking in service could be practically eliminated.

Many of the stress cracking problems were traced back to the use of various tile cleaners for removing excess mastic and imparting a polished or destaticized finish. The data in Table 6 show the wide variation in the effects of seven commercially available cleaners on polystyrene's critical stress in just 30 seconds of application time.

It was no wonder that some tile were cracking when high molding stresses, application stresses, and thermal expansion stresses were all at work on moldings severely weakened by contact with some mastics and cleaners. It is hoped that as this new technique for determination of critical stress is developed and used more widely, new and greatly improved specifications for wall tile, mastics, cleaners, and destaticizers may be written so that quality standards may be measured and enforced more effectively.

EFFECT OF EXPOSURE. Sufficient data are not yet available to list equilibrium critical stresses resulting from the exposure of polystyrene to a variety of conditions. Short-time tests have been conducted, however, and the results are given in Table 7.

Table 7. Effect of Various Exposure Conditions on Styron 666 at 75° F.

Exposure	Time, Hrs.	Critical Stress, % (after 30 secs.)
None	0	3,500
Dark oven at 170° F.	850	3,200
Fluorescent light (std. white)	850	3,500
"Black light"	850	3,200
Weather-O-Meter	100	3,500
	200	3,300
	450	3,100
Fade-O-Meter	100	3,400
	200	3,200
	450	3,000
Germicidal light	200	2,300
	450	2,000
G-E Sunlamp at 140° F.	200	2,000
	450	1,500

From these data, it is clear that there is an appreciable effect on the critical stress of polystyrene resulting from exposure to various light sources. It is apparent that prolonged heating in the absence of light does little harm as long as stress is not applied to the molding until it cools down. It is also apparent that as the wave length of the light decreases and its accompanying temperature increases, the adverse effect on critical stress becomes more pronounced. The latter helps to explain why polystyrene and other plastic moldings stress crack so markedly during exposure in Arizona.

Effect on Electrical Properties

Polystyrene's electrical properties are not degraded by stress cracks unless there are entrapped contaminants. The data in Table 8 brings this out clearly.

Table 8. Effect of Specimen Condition on Electrical Properties of Injection Molded Styron 666 Clear at 75° F.

Condition	Dissipation Factor, x 10^{6}
As molded	0.0001
Crazed (while stressed) in normal heptane	0.0006
Stored one week at 75° F. and 50% R.H.	0.0006
Dried in oven for 24 hrs. at 150° F.	0.0001
Soaked 24 hrs. in water at 75° F.	0.0007

Effect of Finishing Operations

As time goes on, more and more polystyrene moldings are being subjected to a variety of finishing operations. In some cases, these operations are conducted without contact with reagents and without a rise in temperature, so there are no difficulties because of stress cracking. In other cases, stress cracking may result from one or more of the possibilities discussed below.

Machining of molded parts may involve drilling, sawing, tapping, or milling. If these operations are not done very carefully, localized overheating may result and, if sufficiently serious, may cause the development of stress cracks. Liquid coolants must be chosen carefully if further damage to the stressed molding is to be avoided.

Fastening various parts together may be accomplished by the use of adhesives. There are many formulations of adhesives available for such work, each with different solvent ingredients. It is important that the proper adhesive be used in critical jobs, and that adequate but not excessive clamping pressures be employed to effect a good bond without initiating stress cracking.

Fastening also may be accomplished by the use of self-tapping screws, rivets, bolts, hinges, spring clamps, or snap fits. It is fundamentally important for the designer to keep polystyrene's critical stress in mind when designing or specifying such parts. It is equally important for the workman on the job to mold the article without excessive stresses, and to assemble the parts with sufficient care to prevent the localized overstressing of certain areas and the attendant development of stress cracking.

Buffing, if carefully done, may produce the desired effect of imparting a high polish to previously marred areas of a molding. If carelessly done, it may produce undesirable localized overheating and the subsequent development of stress cracks, particularly if a polish is used which effectively lowers polystyrene's critical stress.

As previously noted, some lacquers have serious effects on the critical stress of polystyrene. This emphasizes the two-fold need for designing and molding the part so that a minimum of internal stress exists, and also for choosing and applying a lacquer so that adequate adhesion may be attained with minimum loss of useful strength.

Another point worth mentioning is the need for careful selection of all protective coverings or tapes intended for direct application to finished parts. Some innocuous looking masking tapes in actual use on clear polystyrene sheets have been found to lower the critical stress level to 500 psi. A change in adhesive formulation eliminated

the stress cracking difficulties which had been encountered in these particular cases.

Size and Visibility of Stress Cracks

Photographic enlargements were made from electron microscope pictures of stress cracked areas of polystyrene moldings. In the gross magnification of 26,000 times, it was possible to see stress cracks of definite width, and to measure and compute their width as approximately 0.000002 inch. This dimension refers to cracks which, although definitely visible to the unaided eye, are nevertheless of the smaller variety characteristic of initial stress cracking. Much larger cracks associated with advanced stress cracking may be several thousandths of an inch wide.

Stress cracks may be seen very easily in crystal clear or lightly colored translucent moldings by virtue of the light reflected off the crack planes which gives a somewhat exaggerated impression of a multitude of internal fissures. Reflections from a brilliant light source are nonexistent in opaque moldings where internal stress cracks cannot be seen, but where surface cracking can be noted under proper circumstances. It has been found that even small cracks may be shown up in most opaque moldings by the use of a red or green paint chosen so as to contrast with the original color of the molding. Blood red may be made up by mixing ferric thiocyanate in alcohol, while green is formed by mixing Malachite green in alcohol. Either colorant, if rubbed in all directions on the surface of a molding with a soft cloth and then removed as completely as possible by continued rubbing with clean cloths, will make stress cracking patterns stand out clearly on the surface of opaque moldings.

Determining Internal Stress

It is obvious from the work which has been presented that the developments in the crazing of polystyrene may be put to very practical use in a variety of ways. An attempt has already been made to point out in some detail the reasons why many commonly used articles molded from polystyrene have not always performed satisfactorily in extended use. In this connection, we have tried to emphasize the importance of (1) careful choice of raw material, (2) thoughtful design of the plastic article as well as the mold and auxiliary equipment for making it, and (3) quality workmanship. The desired result is a choice of material with the highest critical elongation in contact with the reagents encountered in actual service, together with a reduction to a practical minimum of internal stresses (in some cases attained by annealing).

A related but totally different use of the same fundamental information involves immersion of molded articles in liquid reagents for the determination of internal stress levels. Thus, by the choice of proper reagents, followed by immersion at controlled temperatures for an adequate time period, the invisible but highly important internal stresses in polystyrene moldings may be determined.

Figure 9 contains all the data needed for such determinations. The composition of normal heptane in isopropyl alcohol necessary to reveal a predetermined internal stress level from 200-500 psi. may be found

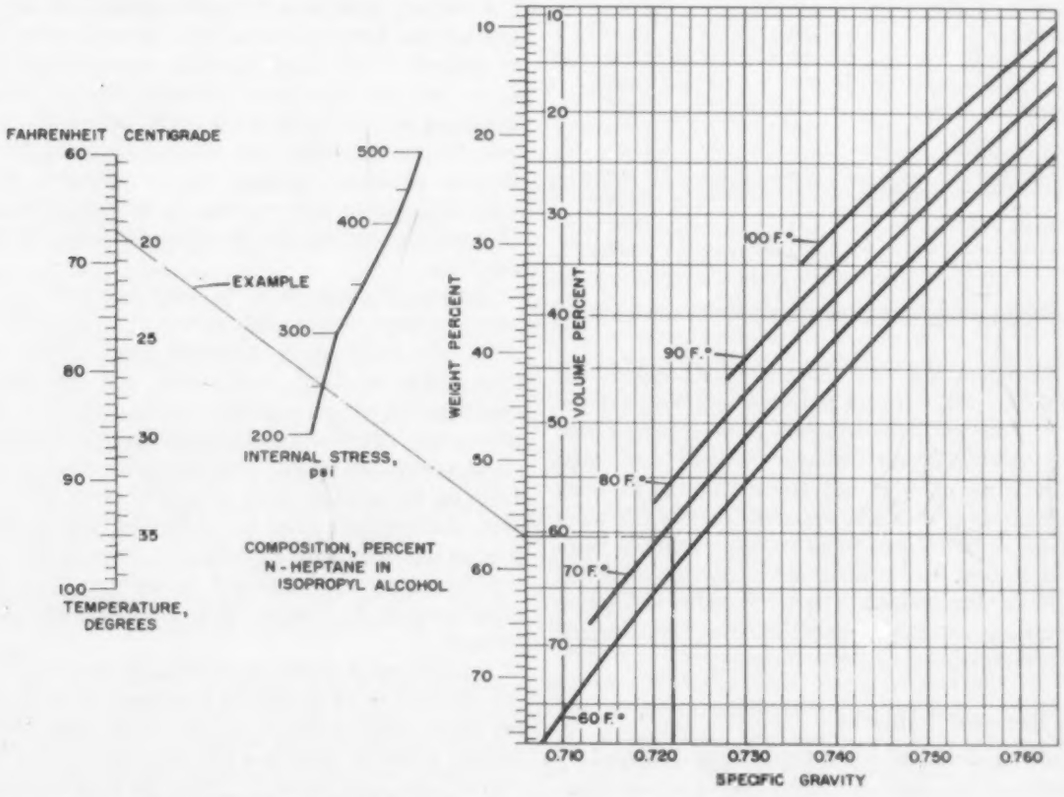

Fig. 9. Determination of internal stresses for Styron 666 general purpose polystyrene.

graphically for test solution temperatures of 60-100° F. Stresses in Figure 9 are based on a tensile modulus for polystyrene of 4.5 x 10^5 psi. This represents the normal minimum modulus obtained on production material.

Use of the chart is illustrated by the following example, wherein it is desired to reveal a residual internal stress in polystyrene moldings of 250 psi. Let us assume that the solution temperature desired is 67° F. By extending a line with a straight edge through the points for 67° F. and 250 psi., the necessary composition results. Thus, a 57% solution of normal heptane in isopropyl alcohol by weight is required, and corresponds to 60.4% normal heptane by volume. The specific gravity of this solution can be found by extending a line horizontally to intersect with the proper temperature. A vertical line extended from the intersection of the temperature line (which in this case must be interpolated between 60° and 70° F.) yields the proper specific gravity. The required solution may be prepared by mixing normal heptane and isopropyl alcohol at 67° F. until a specific gravity of 0.734 is obtained.

A Westphal balance or spindle hydrometer are convenient instruments for measuring specific gravity, but the spindle hydrometer must be calibrated if used at temperatures much higher than 60° F. Reagent-grade normal heptane and isopropyl alcohol must be used to avoid errors introduced by contaminants.

Warning should be given that use of the information outlined in Figure 9 is not as simple or foolproof as it might appear. Considerable study of the problem should be made first, the fundamentals of polystyrene's stress cracking behavior should be understood, and the effects of contributing variables should be appreciated. The following five points should be considered before undertaking actual test work:

(1) Acceptable internal stress level should be predetermined, preferably on the basis of actual use tests.

(2) Moldings must not be tested while still warm; i.e., directly out of the molding machine. They must be allowed to reach equilibrium at the temperature of the test solution before they are immersed in the solution held at constant temperature.

(3) Time of immersion necessarily varies with the type of stress involved, as well as the thickness of the parts to be tested. The data listed in Figure 9 represent minimum data and, in some moldings, it may take 30 minutes or more for even a fast-acting reagent to penetrate the innermost portions of a heavy section where stress cracking may be the greatest. If more stress cracking occurs with additional immersion time, the plastic part has not reached equilibrium and a final decision on exact level and location of internal stress cannot be made.

(4) Parts immersed in test reagents are permanently damaged and should be destroyed. The same part cannot be used for immersion in more than one type or composition of solution.

(5) No two molds are ever made exactly alike insofar as internal stresses are concerned. In setting up test procedures, the average of several trials should be used.

Summary and Conclusions

New testing equipment has been developed and techniques have been perfected which make it possible to study the crazing of polystyrene. This study develops information of fundamental importance in product design and in predicting field service life.

Critical stresses of polystyrene have been determined in contact with a wide variety of reagents under conditions of carefully controlled but widely varied times, temperatures, degrees of orientation, and internal stresses.

As a result of the work completed to date, some conclusions of theoretical value have been drawn. Of more importance from a practical standpoint, much information is now available which should prove very useful to designers, molders, and fabricators of polystyrene parts. Correlation of these laboratory tests with field experience has been excellent. We believe that, in the long run, this will lead to market availability of higher quality plastic moldings, resulting in both wider use and consumer satisfaction.

Acknowledgment

Considerable assistance was given the authors in the preparation of this paper by many individuals in several different Dow laboratories. Two men, R. B. Clarke and R. W. Miler, both of Dow Plastics Technical Service, deserve special recognition for contributing work of outstanding significance.

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—THE END

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Vinyl Lamination Techniques*

Four laminating methods are discussed and compared in terms of problems confronting vinyl laminators.

Basically the theory of vinyl lamination is very simple. Any processor, who when slabbing vinyl from a two-roll mill has overlapped two of the slabbed pieces and allowed them to cool before attempting to separate them, recognizes in a very practical way the theory of lamination. It is simply this: if the material to be laminated is above its fusion temperature (approximately 350° F.) and enough pressure is applied across the area of the vinyl sheets to eliminate bridging, the two vinyl pieces will be laminated into one inseparable mass. If the material is straight polyvinyl chloride, the laminated mass may be placed in some high-powered swelling agent, such as acetone, for many hours with no sign of delamination. However, these conditions are ideal and sound very simple, but many practical reasons make the production of laminated sections quite difficult and subject to good control of pressing conditions.

Laminating Methods

Before considering some of these difficulties it might be well to discuss some of the methods of laminating, what products they are used to making, and the advantages or disadvantages of each method.

Calender Laminating

Laminating of two vinyl films on the plastic calender itself (see Figure 1) first came into prominence when some difficulty was experienced with pinholes in inflatable toys such as beach balls, play pools, and life rafts. A pinhole leaking air out of the toy renders it practically useless. These holes came from very small pieces of heterogeneous material which contaminated the vinyl stock. When the film was stretched, air pressure forced this heterogeneous material out and a pinhole resulted. Some manufacturer reasoned that by calendering one six-mil sheet and then passing it between the middle and bottom rolls of a plastic calender which was producing another six-mil sheet, you would obtain a 12-mil laminated vinyl sheeting which would probably not have a spot containing an impurity coinciding with a similar spot in the other layer.

Of course, this method is more expensive than calendering 12-mil sheeting in one pass. However, as vinyl resins were improved to contain less gel spots, electric arc testers were used to detect holes, and general plant housekeeping was improved, the one-pass vinyl sheeting found more and more acceptance because of less pinholes trouble.

Today, only about 3-5% of inflatible material is laminated on the calender. One inflatable fabricator laminates two 5-6 mil films together by a special solvent method, and this accounts for approximately another 10% of the inflatable market.

As can be seen, laminating at the calender is expensive and has only two basic advantages: (1) the laminated material may offer something a one-pass film does not; and (2) the method can build thicknesses that are greater than the feasible calender range for one-pass film. The second advantage is not too practical because in these thicker ranges it becomes necessary either to heat or activate by solvents the externally introduced sheet. The latter procedure is fraught with pitfalls.

The upholstery and automotive trade uses supported vinyl material made by laminating cloth to vinyl at the calender. The procedure is to anchor coat the cloth, and then preheat just before the cloth enters between the

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middle and bottom rolls of the calender which also carry the heat-softened film of vinyl. This results in a very good bond, economical lamination on large runs, and less heat history on the vinyl material itself.

There are some difficulties involved with this method: small runs are very difficult; material passing through cannot be reclaimed if calendering difficulties are experienced; and vinyl thicknesses of 6-8 mils are the thinnest that can be run economically. These thicknesses, as well as thinner ranges of vinyl, can be applied more cheaply by spreaders with organosol and plastisol coatings. Spread coating produces about 40% of all coated fabrics, and only about 10% of vinyl-coated fabrics are made by post-laminating a precalendered vinyl film and an anchor-coated cloth.

Roller Laminating

Roller laminating is the second method. The machinery (see Figure 2) consists of one rubber roll and one steel cylinder, either smooth or embossed, which are pressed together with adjustable pressure by air cylinders. As the rolls rotate, either two preheated vinyl films or one preheated film and one preheated anchor-coated cloth are fed between the rolls. The two materials will bond together if the laminating conditions have been met, that is, if both thermoplastic vinyl films have reached their fusion temperatures, and enough pressure is exerted to overcome bridging.

Many decorative applications have been found for laminates of thin film made by this method, but much care must be taken while preheating these films that they do not melt or distort and cause wrinkling as they enter the nip. This method has produced more flexibility in manufacturing, and a slightly more expensive material, weight for weight, but no tying together of calendering problems with combining.

This method for producing combined goods is growing slowly but may expand greatly because of new evaluations which may indicate that this method applies less vinyl than calendering, yet gives similar physical properties of the finished sheet.

Press Laminating

In considering machinery development, we recognize that much vinyl processing first had to be done on existing rubber equipment, and the press was no exception. It consists of a hydraulic ram with a series of hollow platens which are piped for both steam and water. As the ram is dropped, these platens are lowered a prescribed distance and allow insertion of the material to be surfaced or laminated.

Toward the end of World War II, a highly polished vinyl stock was used for ladies' handbags, and the press making rubber laminates and heels was used to produce this effect. The vinyl material was placed between a highly polished chrome-plated plate and a matte plate (see Figure 3). This sandwich then was enlarged until 10-12 vinyl sheets were assembled.

To protect the expensive chrome plates against damage, an aluminum caul or plate was placed on both the bottom and top of the large sandwich and enough pressure-equalizing material, such as paper or felt, was placed on top and bottom of the caul. This sandwich

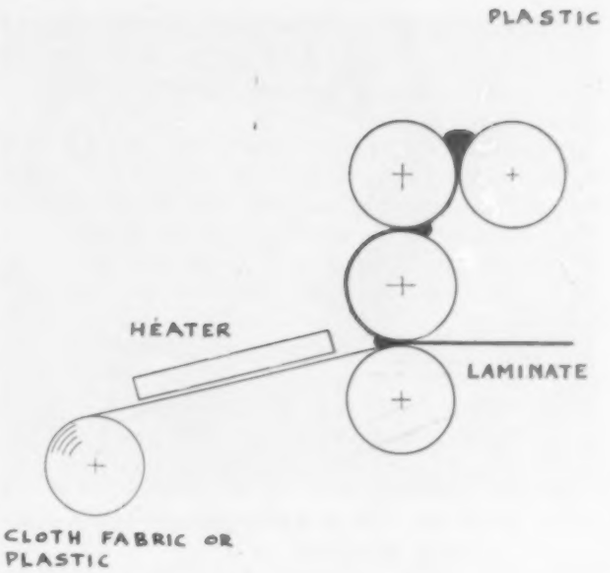

Fig. 1. Laminating vinyl film on a calender.

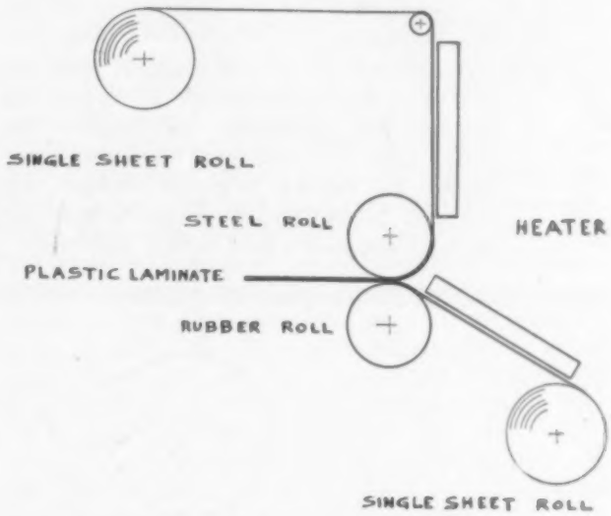

Fig. 2. Laminating of vinyl film between pressure rolls.

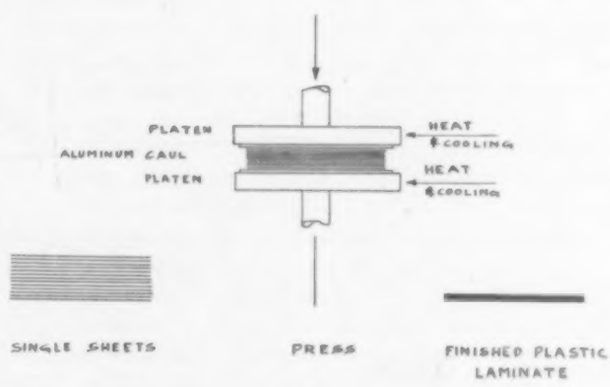

Fig. 3. Press laminating of vinyl film.

assembly was introduced between two steam heated platens and the press closed. After an adequate heating and cooling cycle, the press was opened and the material stripped out.

If laminating was desired, several plies of vinyl were stacked together and placed in the sandwich. However, the need for higher heats, faster changes from hot to cold, and more even overall temperature were some of the driving factors in producing the fully automatic presses that are used today for vinyl surfacing and laminating.

A typical cycle for an automatic polishing or laminating press would be as follows:

(1) Press closes to contact pressure only.
(2) Blow-down opens to let all cooling water out.
(3) Steam is turned on.
(4) Blow-down closes.
(5) When the press is warm enough, intermediate pressure is applied.
(6) Top pressure is applied when the temperature is high enough.
(7) Steam is shut off.
(8) Cooling water is introduced (first a mixture of condensate from the platens and cold water).
(9) Full application of cold water.
(10) Press opens.
(11) Cold water shuts off.
(12) Press unloaded and loaded manually with the help of an adjustable elevator which contains the unheated sandwiches and receives the heated ones. After receiving the heated sandwiches, the elevator height is changed, the unheated sandwiches are placed between the press platens, and a new cycle is started.

This, of course, is an ideal situation and eliminates many of the headaches of vinyl lamination. However, presses of this kind are being used primarily to polish vinyl for the ladies' handbag market and, consequently, are very small in size. Lamination of 2-20 mil clear film is being done on this type of press for the rear windows in most late model convertible automobiles. Some rigid vinyl sheets of the copolymer type have been laminated on presses when thicknesses greater than that produced on the calender are required. Also, some of this material has been laminated to include leaves, grass, decorative cloth, etc., between two layers of either rigid or flexible vinyl.

Another small but growing field for vinyl lamination is unplasticized vinyl chloride for the chemical resistant industry. Since thicknesses from ⅛-1 inch are required for this purpose, it is necessary that multiple calender sheets be stacked on each other until the desired thickness is obtained and then placed in a press either in sandwich form or, if thick enough, directly into the press opening as one thickness. A temperature of 350° F. must be reached and minimum pressure is applied to eliminate bridging.

This pressure varies considerably from press to press owing to varying platen machine tolerances, and is influenced by the size of the press. Press sizes being used for this work vary now from 2½ x 5 to 4 x 8 feet. Other precautions must be observed in laminating this material, but the basic principle of all sheets reaching fusing temperature and applying enough pressure to eliminate bridging is the main formula for good lamination.

A considerable amount of vinyl floor tile is being laminated in presses but this, plus the advantages and disadvantages of press lamination, will be discussed

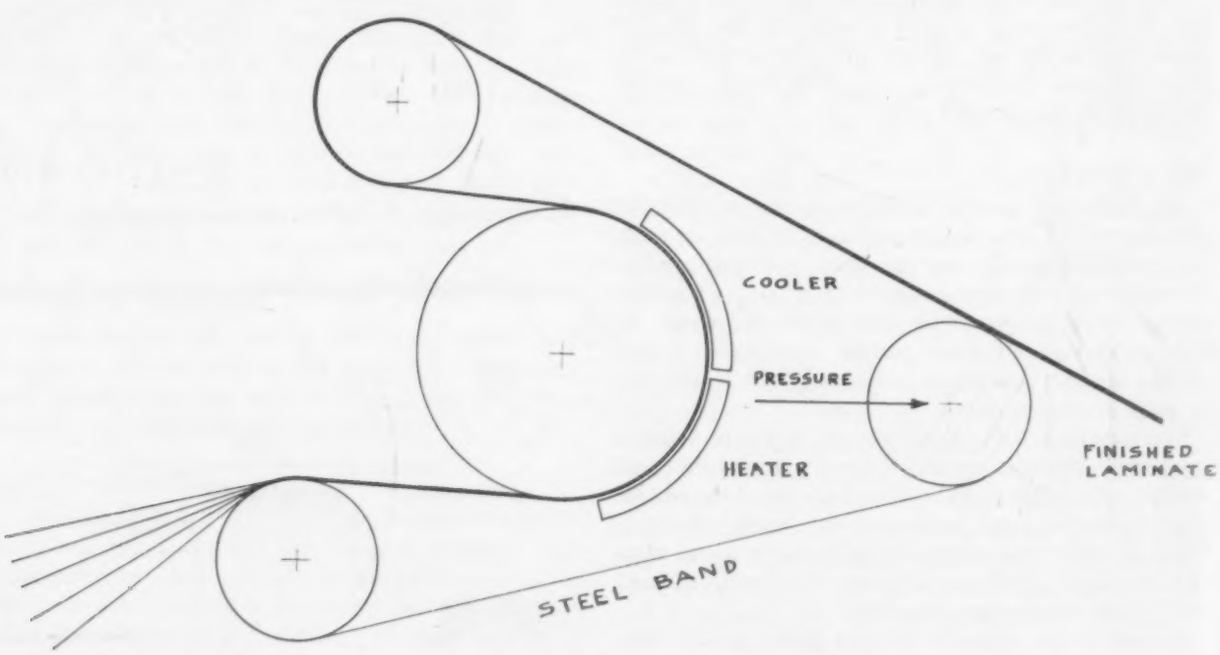

Fig. 4. Schematic drawing of Rotocure laminating process.

under the next method of lamination.

Rotocure Laminating

Basically, the Rotocure is also a piece of rubber processing equipment, and was developed and patented by John Beier, of Boston Woven Hose & Rubber Co., for curing rubber belts in continuous lengths. Because of the need for a time-temperature cure in rubber, it was necessary that this machine turn at a relatively slow speed, something like 1-2 yards per minute. However, when one of the vinyl tile manufacturers recognized that using heated vinyl plies could increase this speed, he decided to install a Rotocure for making vinyl tile.

Essentially, the Rotocure (see Figure 4 and 5) consists of a large smooth drum, approximately 5-6 feet in diameter, around which runs a band of high tensile steel. This band loops around two other large idler rolls, each approximately 40 inches in diameter, for directional change and then around another large drum which is moved by hydraulic cylinders. If the vector of force is exerted to the left on this second drum, force is exerted in just the opposite direction around the big drum. Several plies of vinyl sheeting are passed between the belt and the drum, and hydraulic pressure is applied. The heat source is located around one quarter of the big drum circumference, and on the top quarter are cooling shoes which cool the laminated material.

With the use of master rolls of vinyl sheeting and the interleaving of splices when a roll runs out, laminated material can be produced in continuous sections. As is evident, there are many advantages to this type of lamination besides continuous length, close gage tolerance, and no lay-up of the vinyl material into sandwiches which is necessary when using a platen press.

There is another basic advantage of the Rotocure over the platen press for laminating; that is, almost ideal lamination conditions occur in this operation. The Rotocure first applies minimum pressure at minimum heat; applies gradual but constantly increasing heat and pressure until the point of maximum pressure at maximum heat is reached; maintains maximum pressure while the cooling cycle starts; and, finally, gradually reduces both pressure and heat until minimum pressure at maximum cooling occurs as the last stage of the cycle. This last step helps to produce more strain-free sheets.

The economics of Rotocuring is also a factor of interest. One vinyl floor tiling firm is running both 0.080- and 0.125-inch thick tile in one pass at speeds up to 14 feet per minute with good gage tolerance, and believes that the cost of making a tile in this manner, exclusive of material, is about one-fifth that of the best press-operated method. Our own company, which is making a 3/16-inch flexible vinyl tank lining material in one pass at 7-8 feet per minute, and also a 1/4-inch straight unplasticized PVC rigid material for the chemical resistance trade at 5-6 feet per minute, feels that our costs are approximately one-third those of press laminated material. Higher speeds are anticipated with the development of better sheet preheating methods, and faster cooling methods must be developed.

Just as calendering vinyl on rubber calenders showed us that drilled rolls must replace cored rolls and water-cooled bearings were necessary to keep the lubricating oil from carbonizing at the higher operating temperatures, so with the Rotocure there are some real development problems to solve.

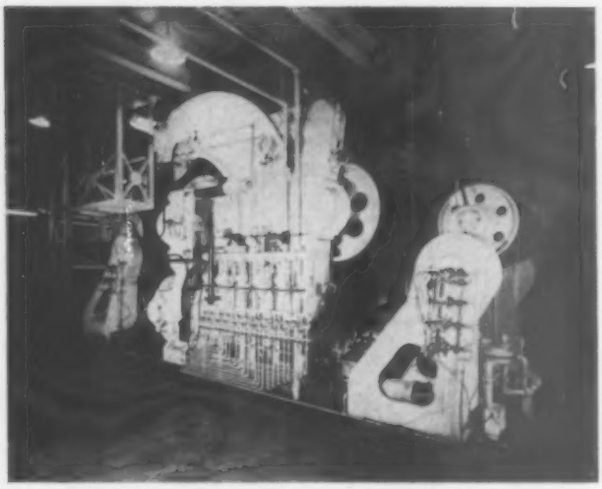

Fig. 5. Rotocure used by Kaye-Tex for vinyl laminating.

Probably the biggest problem is maintaining the tension belt on which the pressure is applied. These belts are generally made of high carbon, high tensile steel, approximately 0.080-inch thick, and consist of 50- or 60-foot strips each 18 inches wide welded together for widths up to 88 inches. These belts were satisfactory for rubber laminating, but many failures have been experienced with them in vinyl lamination.

The use of much higher heats, some of them up to 500° F.; the faster running speeds previously mentioned; flexing in both directions around the rolls; and the additional tension put on one edge or the other so the belt will keep tracking have caused many failures. Some 99% of these failures occur at the welded section, which would indicate that either the weld is not properly stress relieved or there is additional thermal stress set up at the time of welding. Some people feel that the weld is the weakest point when it experiences continual flexing at these high temperatures.

Considerable development work is going on now with the hope of making a belt which will be able to withstand hotter temperatures at even double the top speeds now running. There is still some controversy as to whether to use gas or electricity to obtain the needed high operating temperatures.

Conclusion

I would like to re-emphasize the inherent difficulties of laminating vinyls, and the reasons why good controls are utterly essential no matter which of the four laminating methods are used. These reasons are:

(1) Vinyl chloride is a poor heat conductor and, therefore, driving heat through any large mass is very difficult.

(2) Vinyl chloride will heat degrade, and its properties are affected during lamination.

(3) The coefficient of linear expansion is high for polyvinyl chloride. This may cause strained sheets, particularly if the laminate is allowed to clinch over the edge of the plate in its hot state,

(Continued on page 432)

Guest Editorial

The American Evolution

HERMAN R. THIES, *General Manager*
Chemical Division
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Akron, Ohio

Since the signing of the Declaration of Independence in 1776, America's struggle has become one of constant and progressive evolution. Evolution in this sense may be applied to the improvement of mind and body since the days of the Revolutionary War. It might be called the American Evolution, whereby that indomitable will and spirit which led to the early development of the country's wilderness, and which eventually engendered the spark of American industry, has been kept alive. American industry has shared in this evolution since the invention of the cotton gin launched our Industrial Revolution. The hard work and ingenuity of the American citizen has since developed creativity and the most highly mechanized industry in the world. It is this combination of mind and machine which has enabled Americans to build industry upon industry, each complementing the other.

One of the most recent additions to the evolving scene is the plastics industry, which taxes both man's mind and his productive ability. We at Goodyear are proud to be a part of this young industry and to partake of the rewards which come from doing a job well in advancing applied plastics technology. In addition to research and development activities, we are presently producing resins and latices for the manufacture of countless commercial products.

We concur with the Statement of Principles by the Plastics Industry:

"Plastic materials challenge industry with new concepts of design, engineering construction, processability and usefulness . . .

"Properties of plastic materials, when correctly used, open up great new areas of service to industry and the public . . .

"We, as manufacturers and processors of plastic materials, reaffirm our adherence to the principles upon which the healthy growth of a great industry depends . . .

"All to the end that plastic materials already available, and others that may come, will bring to industry and public alike all the benefits, economics and satisfactions inherent in these versatile engineering and construction materials."

"By meeting the challenge of technology, we should all share profitably due to plastics' role in the American evolution."

We feel that the plastics industry will find new and endless boundaries in this ever-changing American competitive scene with objectives such as these.

As examples of the forward progress of the plastics industry, we cite the high-impact resins which are bringing a new technology to the field. They are the most impact-resistant of all rigid thermoplastics; are unusually heat-resistant; and are readily molded, extruded, post-formed, and fabricated.

Dry-blending vinyl resins, which have come about only in the last few years, are also affording new possibilities in the industry. Typical of these dry blends are the electrical grade vinyls which are being consumed at a pace which is expected to triple present production rates in the not-too-distant future because of increased demand for electrical appliances and goods.

From the processing equipment standpoint alone, dry-blend resins eliminate the need for expensive processing equipment, thus saving time and money for the converter.

Other outstanding vinyl resins for general-purpose use are also being made available in greater quantities due to the increased demand for them in consumer items.

Plastics for coating applications, such as organosols and plastisols for the coating of textile fabrics, are finding new and increased uses daily. Rigid vinyl material is another plastic which has an unchallenged position for use in tank linings, plating racks, chemical duct systems, acid-resistant pipe, and other fields where high resistance to attack by chemicals and the elements is imporant.

We constantly find that plastics are being used by every industry in the fabrication of its parts and equipment. In addition, plastic products are replacing innumerable items which were formerly made with other materials such as metal and wood. As a result, production in the plastics industry over the past decade has increased five-fold. This expansion can be attributed principally to the rapid strides made in the chemistry and testing of plastics, and the derivation of better processing techniques.

Even with this vast range of plastics technology at our disposal, we know that the surface is just being scratched. We know the day will inevitably come when present-day knowledge and methods will be inadequate due to the evolution of a new technology.

It seems logical to assume, therefore, that the American Evolution presents the plastics industry with an intriguing challenge and a chance to forge a new frontier.

The challenge is to raise the technology to a new level and, in so doing, to possibly create other new industries in the process. By meeting this challenge we all will share profitably in the evolution. As a consequence, the plastics industry will be making a great contribution to American industry and life.

—The End

"In spite of rapid strides in chemistry and processing, plastics technology is just beginning to assume its role in industry."

H. L. DARBY, *Vice President*
Winner Mfg. Co., Trenton, N. J.

Designing for Reinforced Plastics*

How to determine the manufacturing method, mold material, and part design to meet specific product requirements.

The general term "design" is often defined as the arranging of details into an economical, efficiently useful product. The design of reinforced plastic items is no different in this general sense than the design of almost any other manufactured product.

Products in most businesses involve two requirements: those for selling, and those for manufacturing. Without proper consideration of both of these design fields, a successful and continuing production is not possible. It is obvious that a product having the best possible design for utility cannot be a success if customers will not accept it because of unpleasing appearance, color, or other esthetic factors. On the other hand, the most beautiful product cannot be sold on a continuing basis if it does not adequately perform its intended function. From this we see that these two general design fields cannot and should not be divorced, but must work together harmoniously for the complete success of any design undertaking.

For the purpose of this paper, we will assume that design for manufacture will lead automatically to good design for selling and use. Although this is not always the case because of styling and other factors, proper manufacturing design usually will provide the best appearance, uniformity of product, and highest quality at lowest cost necessary in good design for selling.

The physical, chemical, and electrical properties of reinforced plastics can be and are varied through a wide range of values. This ability to be varied, while opening the way to wide usage in many industries, at the same time requires a much more careful approach to the design of a product than one involving the use of steel and aluminum. These usually have known and unvariable properties for a specific alloy.

Manufacturing Variables

The basic difference between design for manufacture of these metallic materials and a similar reinforced plastic product can be summarized adequately, as follows: the manufacture of an item utilizing reinforced plastics involves not only the construction of a shape, but at the same time the making of a material which can have a wide variance of properties.

The properties of a reinforced plastic part can vary because of:

(1) The type of resin used.
(2) The type and form of reinforcement material.
(3) The ratio of resin to reinforcement.
(4) The type and ratio of other filler material used.
(5) The method of manufacture of the part.

Illustrating these factors, the resin can be rigid, flexible, or a combination thereof; fire-retardant; light-stabilized; or an electrical grade material. The reinforcement can consist of glass fibers, vegetable fibers, mineral fibers, or a combination, and can be in the form of preforms, mats, woven fabrics, or combinations. The filler materials used may be clays, silicates, carbonates, etc.

Manufacturing Methods

There are five methods of manufacturing reinforced plastic parts, namely, contact, injection, vacuum bag, pressure bag, and matched die. Each method has its inherent properties and applications.

* Based on a paper presented at the Eleventh Annual National Technical Conference, Society of Plastics Engineers, Inc., Atlantic City, N. J., Jan. 21, 1955.

Contact Method

The contact or no-pressure method involves the placing of the reinforcement on an inexpensive mold shape, either convex or concave, saturating this lay-up with resin, usually by brush or squeegee, and working out any entrapped air by hand as well as possible. Cure is effected either at room temperature or accelerated in an oven.

This process is frequently used to produce single prototype units or samples. It is apparent that with this method a high resin content results, with consequent poorer physical properties than with controlled methods. The resulting parts are produced with:

(a) Low tooling cost.
(b) High unit labor cost, owing to the slow cycle and the labor required to sand and clean up the molded part.
(c) Non-uniform physical properties.
(d) Low physical properties because of high resin content.
(e) One surface irregular.
(f) Non-consistency of parts.

Injection Method

The vacuum or pressure injection method is another process generally used to make sample or prototype parts, but both this and the contact method are used in some instances for the production of limited-volume parts.

In the injection method male and female molds are used, constructed with a predetermined gap between them. The reinforcement is put in place, usually on the male mold, and the female is positioned over it. A moat is provided at the edge of the positioned forms into which the catalyzed resin is placed. A vacuum is drawn from one or more high spots in the mold, causing the resin to rise and fill the mold gap and saturate the reinforcement. This vacuum is sometimes augmented by positive pressure applied to the resin in the moat to increase the differential and help the resin flow. Cure is effected at room temperature or accelerated by means of lamps, ovens, or other heat sources.

Parts made with this method have:

(a) Moderate tooling costs.
(b) High unit labor cost, owing to the slow cycle.
(c) Non-uniform physical properties.
(d) Low physical properties because of the high resin content.
(e) Both surfaces good.
(f) Reasonable consistency of parts.

Vacuum Bag Method

With the vacuum blanket or vacuum bag method (see Figure 1), a single mold is used, either male or female, on which the reinforcement is placed in much the same manner as with the no-pressure method. Catalyzed resin is applied by sprinkle, brush, or spray, and can be regulated to a desired weight ratio to reinforcement, within limits. After a parting film has been placed to cover this lay-up, a flexible blanket is sealed to the mold or the mold is placed in a flexible envelope. The gap between the mold surface and the membrane is evacuated, and causes atmospheric pressure to compress the uncured material. Cure is effected either at room temperature, by ovens, or through the use of heated molds.

Fig. 1. Part molded by vacuum bag or blanket method.

Parts made with this method have the following qualities:

(a) Moderate tooling costs.
(b) Moderate unit labor costs.
(c) Uniform physical properties.
(d) Moderate physical properties.
(e) One surface irregular.
(f) Uniformity of the part.

Pressure Bag Method

The positive pressure bag method (see Figure 2) is identical to the vacuum bag process, except that pressure is exerted through a bladder by means of compressed air. Pressure-resistant molds are required, and cure is usually effected by heated molds.

The resulting parts (see Figure 3) are produced with:

(a) Tooling costs intermediate between those of the vacuum blanket and matched die methods.
(b) Lower unit labor costs.
(c) Uniform physical properties.
(d) High physical properties.
(e) One surface slightly irregular.
(f) Consistency of parts.

Matched Die Method

In the matched die method, male and female molds, usually heated, are used on hydraulic, pneumatic, or mechanical presses. Preformed reinforcements, either mat or cloth, are placed either in the cavity or on the plug, depending on the specific requirements, and catalyzed resin is poured onto the reinforcement. The press is activated, closing the molds which distribute the resin throughout the piece. Hardened shear edges are often used to trim the part during the molding operation. This is accomplished by telescoping molds which, in addition to trimming the part, cause an internal fluid pressure on the resin during molding.

Fig. 2. Part made by positive pressure bag method.

This method produces denser laminates with better surface qualities than the other methods. Cured parts (see Figure 4) have the following qualities:

(a) High tooling costs, although considerably less than for metal-forming tools.
(b) Low unit labor costs.
(c) Uniform physical properties.
(d) High physical properties.
(e) Good surfaces and good tolerance control.
(f) Consistently uniform parts.

Mold Materials

In the order of increasing cost, the following materials are used for molds: plastic; aluminum; mold steel; cast iron; Meehanite; and machine steel. The quality and consistency of the parts made in molds of these materials usually follow in the same order, and part cost varies inversely. It should be noted that completely satisfactory sheet molds made of plastic or aluminum have not as yet been developed.

Selection of Method

To summarize the methods available and the conditions contributing to proper selection of a specific method, the following guide is offered.

The contact or no-pressure method should be considered if: (1) low tooling costs are required; (2) a prototype or only a few parts are to be made; (3) maximum physical properties are not essential; and (4) only one good surface is needed.

The vacuum or pressure injection method should be considered if: (1) additional tooling costs are justified to achieve two good surfaces, and the part is simple in shape; (2) a prototype or only a few parts are to be made; and (3) high physical properties are not required.

The vacuum blanket or vacuum bag method can be used if: (1) volume requirements are small or limited; (2) average, controlled physical properties are desired; (3) the part is too large for existing mechanical equipment; (4) undercuts or reverse draft angles are needed; (5) a large part with internal ribbing is to be made; and (6) only one good surface is required.

The positive pressure bag method should be considered if: (1) larger volumes are needed; (2) good, controlled physical properties are desired; (3) the part is too large for existing mechanical equipment; (4) undercuts or reverse draft angles are necessary; (5) a large part with internal ribbing and inserts is to be made; and (6) only one controlled surface is required.

The matched die method, the fifth described, should be considered if: (1) volume requirements are large; (2) good, controlled physical properties are needed; (3) there are no undercuts or reverse draft angles; (4) two controlled surfaces are necessary; (5) close tolerance control is needed; and (6) the lowest unit cost is desired.

Design Considerations

If in the specific requirements for a part the following desirable or necessary qualities appear, reinforced plastics should be considered for the reasons listed:

(1) Corrosion resistance, since the plastics are unaffected by most corrosive agents.

(2) Good insulation properties with regard to heat, sound, and electricity.

(3) Strength with lightness, since the materials have high strength/weight ratios.

(4) Low handling costs, since the light weight cuts transportation costs while the high strength and impact resistance reduces handling damage and repair costs.

Fig. 3. Positive pressure bag method was used to make this boat.

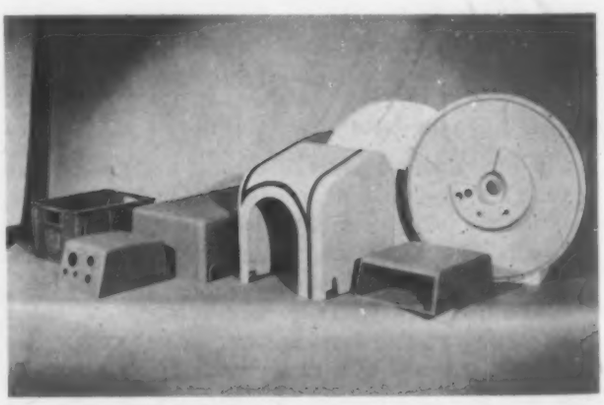


Fig. 4. Parts molded by matched die method.

(5) Low assembly costs, since sub-assembly work with its labor and handling can be eliminated by combining small assemblies into one or only a few readily moldable parts.

(6) The part shape is difficult or costs to achieve in metal.

(7) High impact strength.

If it appears that reinforced plastics can offer economic advantages or other desirable qualities, they can be employed using the following design guides: design should be simple; generous radii should be allowed wherever possible at intersections of planes and at contour changes; draft angle should be as large as possible; wall thickness should be constant, if possible; any necessary section changes should be gradual; reasonable tolerances should be allowed; the part should be designed to replace sub-assemblies by combining their functions; undercuts or back-draft should be avoided; and trim edges should be kept in one plane wherever possible.

These principles should be kept in mind, and the part designed for production by the least expensive method considering quantity, quality, and delivery requirements. In addition, suppliers of the raw materials should be told what method or methods have been considered, and which method is being specified for production.

It is obvious that this discussion of design is general in its approach. Each specific design presents its own peculiar problems that require close investigation. Reinforced plastics is a highly specialized and complex field. We recommend, therefore, that a firm interested in an application for reinforced plastics select a fabricator who investigation indicates is qualified to work with the interested company.

The reinforced plastics fabricating company should have a proven record of performance in its field, good management, an experienced engineering staff, a research and development group, and laboratory and production facilities. Production facilities are mentioned because there has been too much development in the abstract. This fabricator should work with the customer's engineering personnel in all the preliminary stages of design and specification, in addition to acting as a consultant throughout. Simultaneously, the fabricator should initiate in his own laboratory a material evaluation program to determine which materials can best meet the necessary requirements.

After approval of design and materials, the fabricator makes a specimen run of parts for testing. Development proceeds after these tests, and incorporates any needed or desired improvements or modifications. Following this, additional samples modified in accordance with these changes are made and submitted for tests and approval. This procedure continues until a satisfactory item is developed and final approval gained.

This procedure has been followed in other applications, and is known to be successful. In fact, it is the only completely successful procedure known. It follows the theory of making haste slowly, but is designed to answer all problems.

—THE END

Partially-assembled lightweight plastic radar shelter

Close up view of shelter reveals ease of assembly

Portable Plastic Radar Shelter

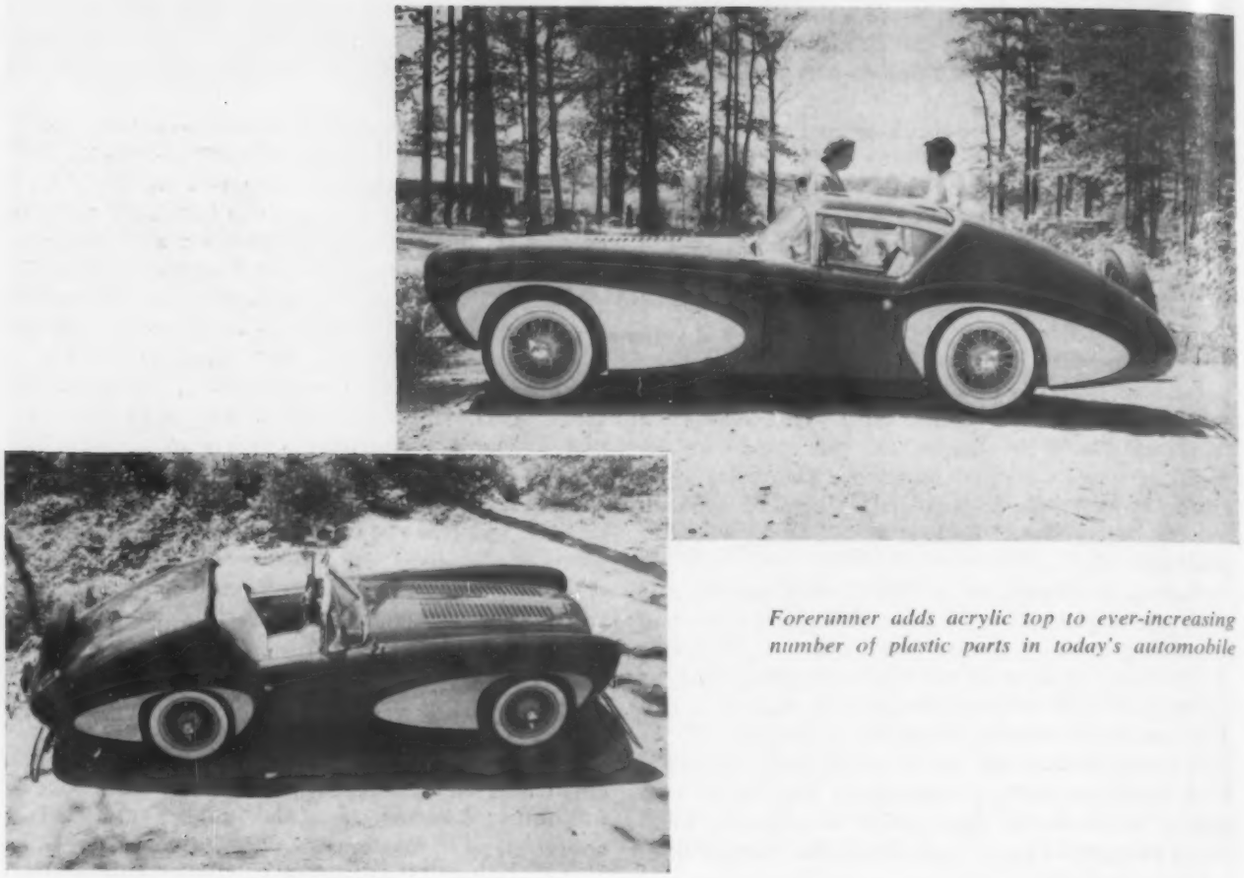
A plastic radar operations shelter, together with a smaller maintenance shelter, have been developed for the U. S. Air Force by Luria-Cournand, Inc., Havre de Grace, Md., designers and fabricators of structural plastics and plastic-based materials. Light in weight and easily assembled, the shelters can be transported by air or truck and set up in less than three hours.

The shelters consist of two arch-shaped structures, each identical in design and made up of interchangeable reinforced plastic sections. Laminac polyester resin, modified by Luria-Cournand for extra strength and adhesiveness, is reinforced with olive drab-colored fibrous glass to form panels seven feet long by 3½ feet wide. The panels are bolted to formed aluminum arches during erection, which proceeds in completed stages from one arched section to the next.

The arches are spaced about four feet apart, and come in four interchangeable sections which are joined in the field by special quick-fastening pins. Flooring of aluminum-faced honeycomb sandwich panels is laid on a series of beams which rest on jacks, allowing the entire structure to be leveled. The shelters have a fiberglass insulation blanket, a rubber vapor barrier, and a rigid fiberglass liner.

A 14-man crew, equipped with ladders and wrenches only, can erect and dismantle the entire assembly within the aforementioned time. Luria-Cournand, Inc., has been producing the shelters for early delivery to USAF bases under contract with General Electric, manufacturers of radar equipment. The shelters are durable enough to withstand winds up to 90 miles per hour.

—THE END



Forerunner adds acrylic top to ever-increasing number of plastic parts in today's automobile

Plastic Hardtop Convertible Automobile

The "Forerunner," a hardtop convertible automobile with a fiberglass-reinforced plastic body and an actually retractible top made of acrylic plastic, has gone on display at the Detroit Historical Museum. Designed by William Flajole, styling consultant to American Motors Corp., as his personal "preview" and workshop car, the Forerunner is unorthodox in both styling ideas and construction techniques.

The car was built directly from renderings, by-passing the expensive stages of full-size layout and experimental bodywork. The body embodies intricate compound curves and perforated planes not previously attempted on a fiberglass-reinforced plastic body. Even the underhood fittings and hangers were molded into the body, which was executed by Detroit Macoid Co. The design was modelled first in a full-size prototype, and reproduced in plaster molds in which the body was built up with fiberglass cloths and resins.

To strengthen the flush hood and prevent any buckling, the hood was built up into a sandwich wall with ribbons of fiberglass. This extra rigidity permitted stamping functional louvres along the full length of the hood to cool the motor, tires, and brakes. The hood rests on the retaining edges were molded into the sidewalls, and the lock plate was molded into the hood. To minimize conducted vibration, the plastic body is asymmetrically mounted to the frame at only seven points, all rubber insulated.

The Forerunner features a retractible Plexiglas canopy which rolls back on tracks into the teardrop-styled tail deck. The canopy is ¼-inch thick and made of Rohm & Haas' 30% transmission green that is opaque to ultra-violet and infra-red rays, and is especially adapted to automobile use. The canopy track runs on nylon bearings. Although the canopy slides easily by hand, it is equipped with a motor to permit operation from the driver's seat.

Green and buff in color, the car has a modified Jaguar chassis; tubular alloy steel bumpers; foam rubber seats with bolsters; headlights recessed behind the grill; a wheelbase of 100 inches; and a top speed in excess of 140 miles per hour. The Forerunner is 51 inches high and weighs 2,100 pounds.

—The End

GEORGE MISTIC, *Director of Research*
Condenser Products Company, Division of
New Haven Clock & Watch Co., Chicago, Ill.

Plastics as Capacitor Dielectrics— 5. Teflon

The conclusion of a five-part series on plastics being used as dielectrics or insulators in the plastics industry.

In recent years the chemist has developed some very promising dielectric materials which have revolutionized the electrical industry. Some materials developed in the past few years have resulted in a new class of dielectrics whose excellent electrical properties are maintained over an extreme temperature range of —90 to +250° C. This new family of chemicals contains the element which imparts the unusual properties shown by these dielectrics. One of these dielectrics, polytetrafluoroethylene, developed by DuPont and trademarked Teflon, is a polymerization reaction of tetrafluoroethylene at high pressures and temperatures. The high temperature resistance of this dielectric becomes something of a disadvantage when the raw tetrafluoroethylene resin is processed into sheets thin enough to be used as capacitor dielectrics.

Teflon is a thermoplastic material but it becomes a gel at 325-375° C., and decomposes when heated at a temperature of 400° C. Specialized techniques are continuously being developed to form the Teflon into a desired shape. Methods have been altered to yield a continuous film of fairly uniform cross-section. Some of these methods are casting, calendering, skiving, and Teflon-dispersion impregnating of glass cloth and glass microfibers.

Currently used to make films to two mils thick is a skiving process wherein the resin is cast in block form and a continuous strip is shaved off. This method, although widely used, results in a film which is streaked with fine grooves, and the defects are so numerous that the film layers must be doubled for use as a capacitor dielectric. Doubling the film, however, means a waste of precious material and increases the volume per unit capacitance at a given voltage rating. Yet the price of skived Teflon is such that it is used more than cast Teflon, which is the second method of manufacturing thin films.

In casting, a suspension of tetrafluoroethylene resin in a liquid medium is poured uniformly upon a drum or polished plate, dried, and sintered at high temperature. Successful coatings can be built up, and each coating covers defects in the preceding coating so that a one-mil thick film of cast Teflon has a dielectric strength 5-10 times that of an equivalent one-mil thick film of skived Teflon.

Another decided advantage of casting is that continuous rolls of cast film can be made as thin as 0.0002-inch and result in a large volume saving for low voltage-rated capacitors. Also, since the fault count is low, the film lends itself to metallizing of electrodes on both sides for use as miniatured capacitors for 200° C. operation.

In general, Teflon is considered by many as the ideal dielectric, and by others as seriously lacking certain qualifying factors to be the ideal dielectric. Although it has high chemical inertness, practically zero moisture absorption, is stable under continuous operation from —90

to +250° C., has good mechanical strength, small voltage derating factor for high temperature operation, high insulation resistance, and low loss factor (dielectric constant dissipation factor), Teflon cannot be manufactured easily, has a rather low dielectric constant, large coefficient of thermal expansion, low corone resistance when unprotected by insulating oils, yields toxic fumes when decomposed by heat or an electric arc, and deteriorates under x-ray bombardment.

Since Teflon was first mass-produced in 1943, Condenser Products Research Department has developed this film into a capacitor dielectric (see Figure 1) where, in several instances, no other dielectric was compatible. To understand the advantages and disadvantages of this dielectric, it is necessary to examine the general physical, chemical and electrical characteristics of Teflon.

Fig. 1. Soldering the end caps and studs on a large Teflon capacitor which is to be contained in a glass case.

Physical Characteristics

In order that a film may be wound on rolls and evenly rewound upon a mandrel to produce a spirally-wound capacitor, the film should have sufficiently high tensile and tear strength, and should not stretch appreciably when pulled. Teflon film one-mil and more in thickness can be wound fairly easily since it has a tensile strength greater than 2,000 pounds per square inch, a tear strength of 400-600 pounds per inch, and an elongation of not over 250%. Films that are thinner than one mil are a little more difficult to wind since too much tension on the film will elongate it and narrow its width. However, when the tension is removed, the film will resume its original dimensions. This effect is known as plastic memory.

An advantage of Teflon is that it remains flexible and does not become stiff or begin to crack at extremely low temperatures in the order of —75° C. Similarly, at the high end of the temperature range, Teflon does not soften appreciably and retains its tensile strength to a great degree.

One disadvantage of Teflon is its high thermal coefficient of expansion. In special instances where the Teflon capacitor fits tightly into a confined space, large changes in the ambient temperature will cause the film to expand and contract appreciably, so that the stability of the unit is affected. Also, this high thermal coefficient of expansion limits the thickness of metallizing metal electrodes to Teflon to a small enough value that the metal can contract and expand with the Teflon.

Chemical Characteristics

Teflon film is unaffected by any known chemical except molten sodium and fluorine gas. There is no known solvent for Teflon. Since it is inert to oxygen, there is no oxidation of the Teflon at high temperatures. This characteristic is ideal in those applications where the dielectric is subjected to extremely high temperatures in the order of 250° C.

Since Teflon is inert to dimethyl silicone, this fluid is used exclusively by Condenser Products to eliminate corona at high voltages in those applications combining high voltages and high temperatures (see Figure 2). Also, in certain applications, high temperature polyester resins can be used as impregnants for Teflon in place of fluids, since polyester resins do not attack Teflon.

Although Teflon is considered as having an almost zero percent water absorption, moisture will be absorbed by Teflon. A quantity of 0.2 gram of water per 1,000 square inches of surface area per day was detected to penetrate one-mil thick Teflon. Although this is an extremely small quantity, it can affect the power factor and surface resistivity of the Teflon. In order to obtain the ultimate in volume and surface resistivity, moisture is driven out of the dielectric by a heat and vacuuming process in manufacturing the capacitor.

Although adherence of materials to Teflon is a problem, certain adhesives, such as "scotch tape" and Mylar adhesive tape, do adhere to the surface of dry Teflon to a sufficient degree that a unit may be handled on the production line.

Fig. 2. Teflon capacitors being removed from an oven where they have been heated to 130° C. to check whether silicone fluid impregnant will leak.

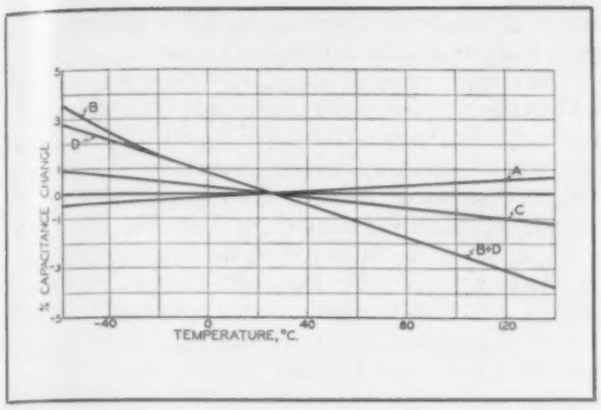


Fig. 3. Effect of temperature on percent capacitance change of various Teflon dielectrics over a frequency range from 60 cycles to one megacycle: A — unimpregnated micro-fiber glass-Teflon; B — silicone-impregnated micro-fiber glass-Teflon; C — unimpregnated Teflon; and D — silicone-impregnated Teflon.

Electrical Characteristics

Capacitance and Power Factor vs. Temperature

Two types of Teflon units are being manufactured in large quantities. One type has no impregnant, while the other is impregnated with dimethyl silicone fluid. Each has its advantages and disadvantages, as noted in the following discussion.

Teflon can be considered as a crystalline non-polar material composed of long-chain molecules of fluorine and carbon. This chain formation is considered the reason for the material's high chemical resistance and excellent electrical characteristics.

The effect of temperature on the capacitance of a Teflon unit depends upon whether the Teflon unit is impregnated or unimpregnated, and whether it is pure Teflon or Teflon-and-glass composite film. Two effects are immediately apparent from Figure 3, which illustrates the precent charge in room temperature capacitance with temperature. The first effect is that the change in capacitance is quite linear, and the second is that, in general, the capacitance decreases with an increase in temperature.

Also, note that when a Teflon unit is impregnated with silicone, the change in capacitance is almost tripled at any temperature. The overall change in capacitance from —60 to +125° C. is approximately 2% for unimpregnated Teflon dielectric alone, and 6% for silicone-impregnated Teflon. The maximum change in this temperature range for micro-fiber glass impregnated with Teflon is approximately 1%. Note that the value for the last item mentioned has a positive change of capacitance with an increase in temperature. When impregnated with silicone, the glass-Teflon dielectric is almost identical in behavior to that of Teflon impregnated with silicone.

Effect of Temperature on Power Factor

Normally, the power factor is measured at a particular frequency, and various standards have various set frequencies of measurement. At one kilocycle, the room temperature power factor for both Teflon, either impregnated or unimpregnated, and glass-Teflon, is approximately 0.01-0.025%. As the temperature is decreased to —65° C., the power factor value remains essentially constant and is approximately 0.015% for all types of dielectrics.

As the temperature is increased to 150° C., the power factor increases. For Teflon alone, it is approximately 0.03%; for glass-Teflon impregnated with silicone, approximately 0.05-0.08%; for Teflon impregnated with silicone, 0.03%, and for unimpregnated glass-Teflon, 0.05%. These values indicate that the effect of temperature on power factor is quite small, and difficulties in accurate power factor measurement ensue.

Capacitance and Power Factor vs. Frequency

The power or dissipation factor of Teflon has been variously reported as being less than 0.0005. Laboratory tests on presently-used skived and cast Teflons show that the power factor of the Teflon dielectric itself is approximately 0.0002 for all frequencies from 60 cycles to three megacycles, and decreases slightly beyond this frequency. Silicone impregnation does not appreciably affect this value. Also, micro-fiber glass-Teflons tested show a power factor of 0.0005 over the previously-mentioned frequency range.

However, when Teflon is used as a dielectric, other factors enter into the picture when power factor is measured. Some of these factors are effects of polarization at the lower frequencies; and at the higher frequencies, the effective resistance of the foils, leads, and terminals comprising the capacitor.

A graph of dissipation factor variation with frequency (see Figure 4) shows that the power factor at the lower frequencies is somewhat higher than that of the pure Teflon power factor alone. As the frequency increases, the power factor reaches a minimum and then continues to rise, rising more sharply at two megacycles. However, this value of power factor depends upon the effective resistance, and will vary in accordance with the size of the capacitor, the amount of foil used, and the voltage rating of the capacitor.

Figure 4 also shows the power or dissipation factors of the smallest and largest capacitors made. In the largest capacitor made, as many as six roll-wound sections are connected in series. It can be seen from these curves

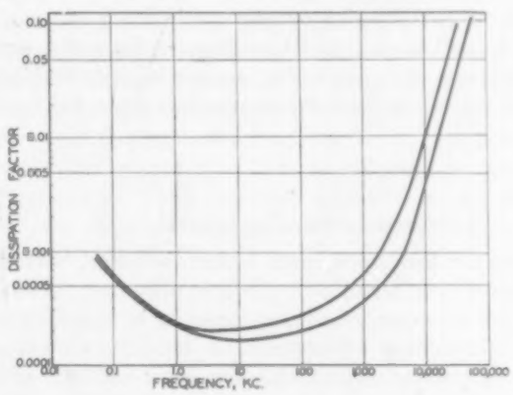


Fig. 4. Effect of frequency on dissipation factor of dimethyl silicone-impregnated Teflon capacitors at temperatures to 125° C. Upper curve is for 24-kilovolt rated units in 1⅝ by 4⅝-inch glass tubes. Lower curve is for 6-kilovolt rated units in small, 1¼-inch glass tubes.

that the power factor is quite small and, in some instances, comparable to, if not better than, mica capacitors of the heavy RF current-carrying type.

The dielectric constant of Teflon is variously reported as being between 2.0 and 2.20. The dielectric constant on presently-used Teflon is measured as approximately 2.05, and the effects of frequency are such that there is no measurable shift in dielectric constant from 60 cycles to 30 megacycles. Other investigators have indicated that there is no shift in the dielectric constant of frequencies as high as 100 megacycles.

However, it is important to note that the capacitance at the terminals will change at the higher frequencies owing to the effects of inherent self-inductance of foils, leads, etc. This effective inductance is kept to a minimum by winding the capacitor section as a non-inductive unit, and using short, heavy copper leads for attachment to the terminals which themselves are made of a non-ferrous metal.

Usually, the residual inductance of a mica by-pass capacitor limits the upper frequency at which the unit can be considered as still giving a capacitive reactance. At a certain frequency, the capacitor will resonate with its own series inductance. This effect is known as self-resonance.

For zero lead lengths, the self-resonance frequency of mica capacitors depends on the capacitance of the unit. A 1,000-microfarad unit has a self-resonance frequency of approximately 60 megacycles, whereas a paper by-pass unit has a 50-megacycle self-resonance frequency, and a silicone-impregnated Teflon unit rated at 1,000 micro-microfarads and 6,000 working volts yields a self-resonance frequency of approximately 100 megacycles. The self-inductance of a Teflon unit, thus, is exceedingly small; in the neighborhood of 0.002-0.004 microhenries. For the larger type of Teflon unit, the value is in the neighborhood of 0.01 microhenry.

Since the effects of frequency are to increase the effective terminal capacitance, the small amount of self-inductance means that this terminal capacitance, relative to the capacitance measured at one kilocycle, will increase only slightly. For a 1,000 micro-microfarad, 6,000-volt, silicone-impregnated Teflon type unit, the effective capacitance will increase approximately 0.5% at 10 megacycles. This change of capacitance and dissipation factor with frequency reaches a minimum value of between one kilocycle to 10 megacycles, depending on the capacitance of the unit. For silicone-impregnated Teflon units, the minimum value is generally around 0.5 megacycle.

Power and Transmitter Capacitors

The silicone-impregnated Teflon capacitor, because of its low power factor and effective resistance, is used as a heavy RF current-carrying capacitor in high-frequency and transmitting applications. It must be remembered that a capacitor used at high frequency will have several different types of voltages applied to it. The working voltage of the capacitor is usually the sum of the DC voltage and all superimposed AC voltages. A second voltage rating is the peak high frequency voltage, exclusive of the DC voltage; and a third is the test voltage which the condenser can withstand for an electrification period of one minute at a 60-cycle frequency.

The current rating of a capacitor, therefore, depends on its effective high frequency voltage, DC voltage, and the temperature rise of the dielectric. At lower frequencies. when the resistance is large, the allowable current for the capacitor depends on the voltage which the dielectric can withstand without breakdown or flash-over.

As the frequency is increased, the limiting factor begins to be the reactive power which gives a temperature rise of 25-30° C. from an ambient temperature of 95-100° C. At frequencies greater than 1-3 megacycles, the current is limited by the heat rise from the I^2R losses arising from the metallic resistance. For a given current at a given frequency, therefore, the voltage is the limiting factor in one instance, and the temperature rise is the limiting factor in a different frequency range.

For example, in a silicone-impregnated Teflon unit of 1,000 micro-microfarads rated at 6,000 volts, the current is limited by an effective voltage of approximately 1,000 volts RMS at frequencies below 500 kilocycles. Thus, at 500 kilocycles the unit will safely pass three amperes. At one megacycle, I^2R losses will cause the temperature to increase and five amps of RF current will produce a 25-30° C. temperature rise over ambient temperature. At three megacycles, the current reaches a maximum of six amperes, while at 10 megacycles the current is decreased to 4.5 amperes owing to increased I^2R losses.

For higher voltage rated capacitors of the same capacitance value, a larger current can be tolerated because of the increased heat dissipating ability of the larger physical size of the container. For instance, a 1,000 micro-microfarad, 18,000-volt, silicone-impregnated Teflon unit at 10 megacycles can safely pass six amperes RF to produce a 25° C. rise, while at one megacycle the safe current rating is 15 amperes for an 18,000-volt unit to produce a maximum temperature rise of 25° C.

Insulation Resistance

The volume resistivity of pure Teflon is greater than 10^{19} ohm-centimeters, and that of microfiber glass-Teflon is approximately 5×10^{15} ohm-centimeters. A capacitor made of Teflon dielectric with no impregnant will have an insulation resistance comparable to that of a polystyrene or polyethylene unit when measured by a two-minute electrification period or by the self-discharge method. The minimum insulation resistance to 168° C. is greater than 500,000 megohms x microfarads.

When the capacitor is impregnated with silicone fluid, this high insulation resistance is decreased and approaches the same value as that of a high-quality polystyrene unit impregnated with silicone fluid. At room temperature, the insulation resistance is in the neighborhood of 30,000 megohms x microfarads, using 500 volts and a two-minute charge time. At 125° C., the value is approximately 100 megohms x microfarads.

Unlike pure Teflon, microfiber glass impregnated with Teflon has approximately the same insulation resistance as silicone fluid-impregnated Teflon when used either as the sole dielectric or impregnated with silicone fluid.

Fig. 5. Mr. Mistic conducts dielectric absorption test on Teflon capacitor.

Dielectric Absorption

The residual voltage build-up of a capacitor which has been charged and then discharged is expressed as a percent of the initial charging voltage. Temperature, charging time, and shorting time will affect this residual build-up voltage. Table 1 shows the percent of charge reappearing on a capacitor charged for one minute, immediately discharged for two seconds, and the voltage measured 30 seconds after discharge. The initial charging voltage was 45 volts DC. Approximately the same values were found when 600 volts DC was used to charge the units.

Table 1. Residual Voltage Build-up

Type	Charge Reappearing, %
Polystyrene	0.02
Polyethylene	0.02
Teflon dielectric	0.02
Silicone-impregnated	2.7
Glass-Teflon dielectric	0.29
Silicone-impregnated	0.55
Mica capacitor	0.7
Mylar capacitor	0.5

Although unimpregnated Teflon alone has a very low percentage absorption voltage, silicone impregnation causes this percentage to increase. For longer discharge times, all values of percentage charge reappearing are correspondingly lower. For instance, for a 10-second discharge, all values are 50% lower. Although silicone impregnation greatly affects the percentage absorption of Teflon, it does not appreciably affect the percentage absorption of the micro-fiber glass-Teflon film. A typical dielectric absorption test is shown in Figure 5.

Corona Resistance

One drawback of Teflon is that it is seriously attacked by corona. The electron bombardment of the Teflon surface, with consequent surface erosion and weakening of the dielectric, will cause eventual breakdown. A triple layer of two-mil Teflon with no impregnant will last from 5-15 hours at 500-600 volts per mil and 60 cycles. At 800 volts per mil, the triple layer of two-mil Teflon will break down any time from five minutes to one hour.

Inspection of the sample shows that wherever there was a sharp point along the edges of the aluminum foil, severe discoloration and erosion has occurred. Consequently, Teflon used alone as a capacitor dielectric must be used at below corona-starting voltages. Teflon impregnated with silicone to eliminate corona and operated at the same volts-per-mil rating as dry Teflon will last almost indefinitely. However, as the frequency increases the presence of corona will cause breakdown at increasingly lower voltages. For instance, for dry Teflon the volts-per-mil breakdown rating when corona is present at one megacycle is 50% of the value at 60 cycles.

Dielectric Breakdown Strength

Since Teflon cannot be made with a great degree of freedom from defects and pinholes, its dielectric breakdown strength in single layers is quite variable. For a single layer of two-mil skived Teflon the value is approximately 200 volts per mil, while for cast Teflon in the same thickness it is approximately 800 volts per mil.

In order to obtain high-voltage capacitors of any degree of safety, double and triple layers of film must be used. For low voltage applications, a single layer of film can be used when it is of cast Teflon or the glass-Teflon variety. For high voltage, pulsed voltage, and radio frequency applications, double and triple layers of Teflon are impregnated with a suitable impregnant.

An advantage of Teflon, whether impregnated or not, is that it has a very small voltage derating with temperature. Certain test samples operating at 125° C. and at 1,000 volts per mil will hold up for several thousand hours without breakdown or deterioration in capacitance or power factor. One characteristic peculiar to Teflon is that at a particular volts-per-mil rating the unit will operate several thousand hours, but as soon as the voltage is increased 25% the unit will have only a 250-hour life. This seems to indicate that the usual fifth-power rule for the life of a capacitor may not be applicable to Teflon film.

Due to the inertness of Teflon to temperature, unimpregnated Teflon units have operated quite satisfactorily at temperatures to 240° C. Since Teflon need not be derated at high temperatures as much as other types of dielectrics, a size reduction for high-voltage capacitors can be realized, despite the film's dielectric constant. In fact, for temperatures of 125° C. and higher, the size of a Teflon unit of 5,000 volts DC rating is smaller than that of any other dielectric, including Mylar, all other factors being equal.

Applications

The low loss of Teflon dielectric when impregnated with silicone fluid allows its use for power and transmitting applications, and for pulse-forming networks. Because of their small dissipation factor and change in capacitance with temperature, Teflon capacitors can be

used in both low- and high-pass filter networks operating in extremes of temperatures.

Unimpregnated Teflon units, because of their high insulation resistance at extremely high temperatures, find use wherever a highly stable capacitor is required. It is essential to maintain the capacitance within close limits as the temperature is varied. Because of its extremely low self-inductance, a Teflon unit can provide a low impedance path to currents at high frequencies.

As previously mentioned, Teflon dielectric is one of the few materials which can operate satisfactorily at temperatures up to 240° C. A size reduction is realized due to the low voltage derating factor with temperature.

Conclusions

Although Teflon cannot be considered as the perfect capacitor dielectric, it comes very close to being just this. Manufacturers of the resin and the film are working unceasingly to produce thinner and more reliable films with regard to defects and weak spots during manufacture. Also, as manufacturing techniques are refined, the price of the material will decrease.

Although much work has been accomplished with Teflon, even newer materials, such as glass fiber- and ceramic fiber-impregnated Teflon films, will be produced in thin gages. These films will have higher dielectric constants, with the same excellent electrical characteristics provided by Teflon alone.

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(6) "Properties and Processing Techniques of Teflon Aqueous Dispersion TD-3," Information Bulletin No. X-50, E. I. Du Pont de Nemours & Co., Wilmington, Del.

—THE END

Vinyl Lamination Techniques
(Continued from page 419)

or if pressure is not reduced quickly enough when cooling.

(4) Vinyl chloride can be surface adhered without complete lamination if the fusing temperature (above 350° F.) is not reached or insufficient pressure is applied to eliminate bridging.

We believe that in an approximately five-year period from 1945 through 1950 the vinyl processor changed calendering from an art to a science by applying his own know-how. We believe he is capable of accomplishing the same reform in the laminating of vinyl materials. Some work has already been done along this line, and we encourage further work on this problem for the good of the plastics industry.

—THE END

Exterior view of truck with reinforced plastic trailer

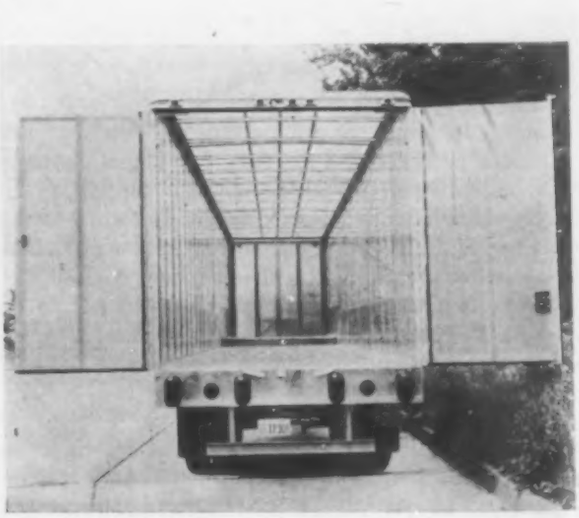
Reinforced Plastic Trailer Truck

A fleet of seven trailer trucks, with walls and roofs consisting entirely of translucent reinforced plastic panels has been completed by Veenema & Wiegers, Inc., Paterson, N. J., for use by the Celanese Corp. of America.

This unique trailer body resulted from the experimental use of fibrous glass-reinforced polyesters as skylights in trucks and trailers. Approximately 1,000 feet of light green panels, supplied by Alsynite Co. of America, San Diego, Calif., were used for each truck. Heavyweight panels were employed as sidings, and standard weight for the roof tops, with sheets butting into aluminum framing.

Lightweight and sturdy, the reinforced plastic trailer provides maximum light transmission to otherwise dark interiors. Alsynite paneling requires virtually no maintenance, being rust- and shatter-proof.

—THE END



Interior view of truck reveals light transmission qualities

News of the Societies

Joseph G. Davidson

Twelfth Annual SPE Conference

Over 2,000 members are expected to attend the 12th annual conference of the Society of Plastics Engineers, which will be held at the Hotel Statler in Cleveland, O., on January 18-20, 1956. Registration will begin Tuesday afternoon, January 17, the annual business meeting and luncheon is scheduled for Wednesday, and the banquet for Thursday evening.

The following phases of plastics engineering will be covered during the conference: injection molding, compression and transfer molding, extrusion, calendering and casting, reinforcement, foams, physical properties, research, tooling and molds, and rigid plastics. Plastics applications, and professional and educational activities of the Society will also be covered.

Frank A. Martin, The Hoover Co., will serve as general chairman for the meeting; with Sherman W. Crawford, Detroit Mold Engineering Co., as co-chairman. Secretary and treasurer, respectively, are Ernest P. Moslo, Moslo Machinery Co., and Jack Pectal, Eastman Chemical Sales Co. The various committee chairmen have been appointed as follows: speakers, William E. Manring, B. F. Goodrich Chemical Co.; program, Hugh Winn, Firestone Tire & Rubber Co.; registration, Harry Zimmerman, B. F. Goodrich Chemical Co.; publicity, Samuel A. McElroy, Hercules Powder Co.; sergeant at arms, R. B. Treer, Warner & Swasey Co.; house, Harold Olson, Harshaw Chemical Co.; printing, A. R. Morse, Injection Molders Supply Co.; advertising, Barney Wolfe, Injection Molders Supply Co.; banquet, Kenneth M. Keller, Keller Products Co.; company registration, R. C. Lopez, H. Muelstein Co.; advance registration, H. D. Oliver, Eastman Chemical Sales Co.; ladies, Miss Elizabeth Goodine, Geauga Industries; prizes, A. Edward Campi, International Molded Plastics; and finance, Ernest P. Moslo, Moslo Machinery Co.

Officers for the coming year, beginning June 11, were announced as follows: chairman, Jack L. Carlson, Paranite Wire & Cable Division, Essex Wire Corp.; vice-chairman, Maurice J. O'Connor, O'Connor & Co.; and secretary-treasurer, John Dixon, Jr., Anaconda Wire & Cable Co.

Annual Fort Wayne Outing

The Fort Wayne Rubber and Plastics Group held its fourth annual golf outing at the Tippecanoe Lake Country Club, Leesburg, Ind., on June 10. Over 210 members attended the outing, which included a three-course lobster and roast beef dinner, as well as a golf tourney.

The golf prize for low gross was awarded to Frances Frost, with a score of 76. Mr. Frost, Frost Rubber Works, won the golf trophy presented by Goshen Rubber Co., and the one presented by Jasper Rubber Co. Ed Hession, Mogul Rubber Co., received the Jasper trophy for the low net handicap with a score of 63.

Detroit Group Plays Golf at Annual Outing

The Detroit Rubber and Plastics Group held its annual Golf Outing at Western Golf and County Club, Detroit, Mich., June 24, with the more than 600 members and guests present setting a new attendance record. Top golfers of the 270 participating included Tom Draper, Schenectady Varnish, and Cliff Greeneisen, The Firestone Tire & Rubber Co., low gross; and C. Petosky, runner-up.

Other prize winners were Bill Innis, Stan Albertson, Pane Bergman, Norbert Crowe, A. J. Bayler, W. F. DeLong, H. Richardson, Bob Watt, M. de Smitt, J. Darin, J. Duchine, W. Whimburg, W. V. Kaul, L. Woerner, and R. Horner. High Gross man for the day was T. Eastburn.

W. D. Wilson, R. T. Vanderbilt Co., was general chairman of arrangements, assisted by J. F. Stiff, Columbian Carbon Co. Others on the committee included Ken Brands and Gale Sharp, Minnesota Mining & Mfg. Co.; Lee Peck, Peck Engineering Co.; Harold Jacober, Baldwin Rubber Co.; Ed Post, Detroit Rubber Co.; Bob Chilton, Permalastic Co.; Jack Masden, United States Rubber Co.; John Craft, The General Tire & Rubber Co.; Bud Jarvis, Wyandotte Chemicals; Sam Schaffer, United States Rubber Co.; and Ed Kvet, Jr., Detroit Arsenal.

Eastern New England Meets

Over 130 members and guests attended the joint meeting of SPE's Eastern New England Section and the Boston-Providence Chapter, SPI, held May 19 at the Quartermaster Corps Research Laboratories, Natick, Mass. Following dinner, J. Alden Murray, director of the Lab's plastics group, spoke on some of the problems encountered in developing plastic articles for the army.

The Natick group have been working on such items as plastic skiis and snowshoes for use in the Arctic regions, and abrasion-resistant plastic dishware. Following the talk, a guided tour was made of the various laboratories and facilities.

To Honor UCC's Davidson

Joseph G. Davidson, vice president of Union Carbide & Carbon Corp., New York, N. Y., has been chosen by the American Section of the Society of Chemical Industry to receive its annual Chemical Industry Medal for 1955 in recognition of his services to applied chemistry. Formal presentation will be made at a meeting of the American Section following a dinner in Dr. Davidson's honor at the Waldorf-Astoria Hotel, New York, N. Y., October 28.

Dr. Davidson, known for his research, production, and administrative talents in synthetic organic chemistry, is acknowledged to be one of the men most instrumental in creating and developing the petrochemical industry. At Union Carbide, he is currently engaged in work programs on atomic energy and the hydrogenation of coal.

Among the honors previously bestowed upon Dr. Davidson was his election as Honorary Fellow of the Royal Society of Edinburgh; an award from the Society of the Plastics Industry for his leadership in the development of vinyl plastics; and an honorary degree of Doctor of Science from the University of Southern California where he had earned his B.A. and M.A. degrees in 1911 and 1912. He holds a Ph.D. degree from Columbia University.

Raymond Stevens, chairman of the American Section, will preside at the award meeting, and Clifford F. Rassweiler, past chairman of the Section, will present the medal.

Standards Conclave Planned

The Sixth National Conference on Standards, co-sponsored by the National Bureau of Standards and the American Standards Association, will be held at the Sheraton-Park Hotel, Washington, D. C., October 24-26, and will have as its theme the cooperation between industry and government departments and agencies in the field of standardization.

The three-day conclave will be addressed by prominent governmental and industrial figures. The nation's two highest awards in the field of standardization, the Howard Coonley Medal and the Standards Medal, will be distributed. Details and registration forms for the conference may be obtained by writing the American Standards Association, 70 E. 45 St., New York 17, N. Y.

SPI Conference Features Caribbean Cruise on "Queen of Bermuda"

Newly-elected SPI prexy, Norman Anderson receives gavel from retiring president, John J. O'Connell, right. New vp Alan S. Cole looks on.

Officers Elected

At the annual conference of the Society of the Plastics Industry, Inc., held on board the "Queen of Bermuda," May 7-15, the following officers and directors were chosen for the fiscal year beginning June 1, 1955: president, Norman Anderson, General Molded Products, Inc.; vice-president, Alan S. Cole, Breskin Publications, Inc.; and secretary-treasurer, William C. Bird, Prolon Plastics, Pro-phy-lac-tic Brush Co.

Chairmen from the different SPI geographical sections elected to the board of directors are: Canada, F. G. Rice, DuPont Co. of Canada, Ltd.; Midwest, Robert W. Jorgensen, The Richardson Co.; New England, C. J. Cowan, Cowan Boyden Corp.; and Pacific Coast, K. R. Mergen, Crest Molded Products, Inc.

Speakers

The business sessions were highlighted by talks on timely topics; abstracts of some of the talks follow:

"Present and Future Markets for Vacuum Formed Thermoplastic Sheet," were discussed by V. L. Kieran, Panelyte Division, St. Regis Paper Co. Although vacuum forming was known before World War II, a significant volume was not reached until 1951, when approximately 2,000,000 pounds of thermoplastic sheet were consumed in the industry. Subsequently, consumption grew to 50,000,000 pounds in 1954, and it is estimated that by 1960 over 200,000,000 pounds will be utilized. Two basic advantages claimed for the process are low cost of tooling and economy of forming thin, large area parts. Present and future trends indicate major markets in housewares, toys and novelties, refrigeration, packaging, air conditioning and home appliances, lighting fixtures, radio and television, furniture, and automotive components.

"Materials for Vacuum and Drape Forming," were covered by John J. Bachner, Chicago Molded Products Corp. First in the field, cellulose acetate is characterized by excellent impact strength and toughness. The principal limitations, which are overcome to some extent in ethyl-cellulose sheet and film, are high coefficient of expansion, dimensional stability, and high moisture absorption. Methyl methacrylate offers clarity and the ability to resist weathering. These factors combined with flexural and tensile strength, help to overcome the higher cost of acrylics. Dimensional stability, low coefficient of thermal expansion, and self-extinguishing properties make PVA the preferred sheet in a number of applications. Polystyrene has excellent finish, clarity, and colorability; however, low impact strength limits its use to the rubber-modified forms and alloys. Latest to enter the sheet forming field, they are dimensionally stable and highly resistant to moisture.

"Equipment Requirements for Setting Up a Vacuum Forming Plant," were outlined by Sanford S. Zimmerman, Vacuum Forming Corp. Granting that the operation can be undertaken with an initial investment of about $10,000 to cover the cost of two machines, he denied that its economy leads to unfair price competition. A standard sized press and a smaller one for developmental work can both be handled manually or automatically by unskilled personnel. He recommended in-plant or easily accessible facilities for making patterns and molds to capitalize on vacuum forming's speedy tooling. The two major methods of obtaining proper registration with preprinted sheets were also explained.

Another feature of the conference was the presentation of the informative labeling award to American Cyanamid Co., New York, N. Y., for identifying a consumer product made of plastics. The prize-winning Melmac dinnerware label carried helpful instructions on care, listing "don'ts" as well as "do's" for the user.

New York Section Schedules All-Day Packaging Symposium

SPE's New York Section has scheduled a one-day technical conference entitled "Plastics for Packaging," for November 16 in New York City. The meeting, first of its nature to be undertaken by the Section, will be open to all SPE members and all others interested in this ever-growing field. Registration fee is $2.00 for members and $3.00 for non-members, $7.50 and $8.50, respectively, with the optional dinner.

Basic plans for the symposium call for speakers from 11 major material suppliers to discuss material properties, processing, and outstanding applications in the packaging field. Technical exhibits which tie in with the talks are also planned.

To sum up the meeting, and to indicate futures and trends, the New York committee has arranged for a leading designer and the buyer from a super market chain to discuss practical aspects of packaging with respect to merchandising techniques.

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NEWS of the INDUSTRY

Barrett Names Western Agents

Two new regional agents for the sale and distribution of Plaskon polyester resins have been appointed by Barrett Division, Allied Chemical & Dye Corp., New York, N. Y. International Sales Corp., Seattle, Wash., will represent their interests in the states of Washington and Oregon, in the Canadian provinces of British Columbia and Alberta, and the territory of Alaska. Roy A. Ribelin Distributing Co., Dallas, Texas, will act as agents in Texas and Oklahoma.

Panelyte Division Expands

A half-million dollar expansion program which will substantially increase its injection molding and vacuum forming capacity has been announced by the Panelyte Division, St. Regis Paper Co., New York, N. Y. The plants involved are the Cambridge-Panelyte Molded Plastics Co. units at Richmond, Ind., and Cambridge, O., as well as the vacuum forming facility at Richmond.

It is estimated that the firm's production of injection molded parts will be increased by approximately 40%, the majority of which will be assigned to the refrigeration industry. Vacuum forming, which had previously been in the experimental stages, will become a full-scale commercial production.

Shawinigan Resins Expands

A million-dollar addition to its Springfield, Mass., plant has been announced by Shawinigan Resins Corp. Scheduled for completion during the fourth quarter of 1956, the new unit will produce Gelvatol polyvinyl alcohol, used as an adhesive for textiles and for textile sizing, paper coatings, and polarized film.

The material has been in pilot plant production for some time, and will be available from the new plant in several grades with varying molecular weights and degrees of hydrolysis. Shawinigan Resins is owned jointly by Monsanto Chemical Co., and Shawinigan Products Corp.; the latter, a wholly-owned subsidiary of Shawinigan Chemicals, Ltd., of Canada. The new expansion follows a recent disclosure that the company will build a plant in Trenton, Mich., for producing Butvar polyvinyl butyral.

Produces Cast Plastic Sheets

The Polycast Corp., 69 Southfield Ave., Stamford, Conn., was formed recently for the expressed purpose of providing cast plastic sheets, rods, and tubes of the following materials: acrylic, styrene, and allyl resin. The firm reportedly employs a unique casting process, beginning with a liquid monomer instead of a molding powder. This is said to result in a product of superior mechanical, optical, and fabricating properties.

The basic raw material is poured into the mold as a liquid and allowed to set under the influence of moderate heat. Plate glass molds are used to produce optimum clarity and dimensional accuracy. Standard four-foot-square sheets are marketed in thicknesses ranging from 0.040-1 inch. Custom dimensions, shapes, and colors are available.

Markets Two-Component Foam

A two-component polyurethane system which can be sprayed or poured has been introduced by Surface Chemicals, Inc., McKees Rocks, Pa. Designated Isothane, the material is applicable for coating surfaces and filling voids where the use of isocyanate foams was previously impractical.

An outstanding feature reported for Isothane is the elimination of costly steam lines, molds, and heat and pressure of any kind. The resin and catalyst are pre-mixed in proper proportions through special metering equipment, and expand upon leaving the blending nozzle. Surface Chemicals' material reportedly expands to a variable controlled density of 3-15 pounds per cubic foot. Chemical, dielectric, thermal, and acoustical properties of isocyanate foams are well known.

Organize Abbey Chemicals

National Lead Co., New York, N. Y., has formed Abbey Chemicals, Ltd., London, England, to produce a variety of chemicals, including stabilizers, plasticizers, gelling agents, and paint pigments. A National Lead subsidiary, Hoyt Metal Company of Great Britain, Ltd., manufacturer of non-ferrous metal products, will hold the major interest in the new firm, with F. W. Berk & Co., British chemical manufacturer, holding the remaining shares. Another National Lead subsidiary, Titan Co. A/S, will act as European distributor for the new company.

Markets "House & Garden" Styrene Molding Colors

Lustrex styrene molding colors which match the "House & Garden" official 1956 home-furnishing colors are presently available from Monsanto Chemical Co.'s plastics division, Springfield, Mass. This should give molders an opportunity to tie-in directly with what is said to be the largest and best known authority for color styling in the home furnishings field.

The publication's current color palette includes 10 basic pastel colors, 16 "current" colors, and 10 "forecast" hues. Formulas will be sent on request to molders using the dry-color method, and permission to use the "House & Garden" name for advertising purposes is granted those marketing housewares in the approved colors.

Monsanto Absorbs Lion Oil

Monsanto Chemical Co., St. Louis, Mo., and Lion Oil Co., El Dorado, Ark., have signed an agreement of merger of Lion with and into Monsanto, according to a joint announcement by Monsanto's president Charles Allen Thomas and Lion's board chairman T. H. Barton. The agreement will be submitted for approval to stockholders of the two companies at meetings called for September 23, and is expected to be approved.

The basis of merger will be the issuance of 1½ shares of Monsanto $2-par value common stock for each outstanding share of Lion stock. Lion had 3,090,912 shares of common stock outstanding as of December 1954. The combination of the two companies will represent total assets of about $550,000,000.

Lion produces ammonia and its derivatives, and has an integrated oil producing, refining, and distributing organization. Monsanto is a large consumer of ammonia and of products made from petroleum fractions or natural gas. The Lion organization, when the merger is approved, will be known as Lion Oil Co., a division of Monsanto Chemical Co.

Lunn Laminates Expands Abroad

As part of a current expansion program, Lunn Laminates, Inc., Huntington Station, N. Y., has appointed Omni Products Corp., of New York City, as its exclusive overseas agent. Omni has already concluded negotiations with Freighters, Ltd., Melbourne, Australia, for the formulation of a new corporation, Freighters-Lunn Industries, Ltd. A new plant is being completed in Adelaide which is expected to be in full-scale commercial production of reinforced plastic automotive parts.

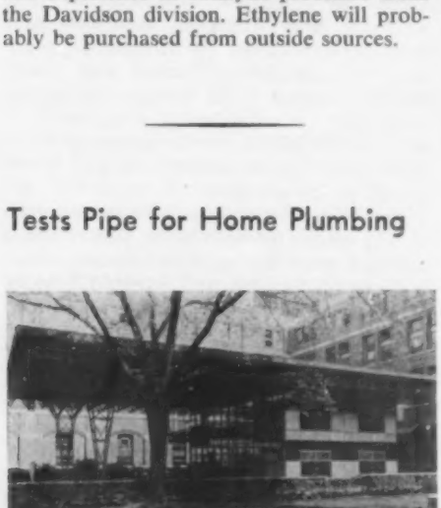
In New Zealand, arrangements have been made with Modern Plastics, Ltd., whereby the firm will receive technical assistance from Lunn for a period of 10 years. As with the Australian firm, technical representatives will be exchanged in order to facilitate production methods. Tuescher Brothers Co., Zurich, Switzerland has agreed to reciprocity on the same terms as the New Zealand firm.

Grace Enters Polyethylene Field

W. R. Grace & Co., New York, N. Y., has announced the signing of a license agreement with Phillips Petroleum Co., Bartlesville, Okla., which will permit them to produce polyethylene by the latter company's method. Grace is presently considering plant sites for the erection of a suitable facility, and current plans call for completion of engineering studies by the end of 1955. Construction will begin during the first half of 1956, and the plant should commence operation early the following year.

The project will involve an investment of over $18-million, raising the company's total capital employed in the chemical industry to more than $150-million. In setting up the new plant, the parent company anticipates calling upon production technology in petrochemicals from Grace Chemical Co.; knowledge in resin applications from the Dewey & Almy division; and experience in catalytic processes from the Davidson division. Ethylene will probably be purchased from outside sources.

Tests Pipe for Home Plumbing



Model school building features all-vinyl plumbing and translucent vinyl ceilings

Rigid vinyl pipe is being evaluated as "house-plumbing" in a model school building erected on the campus of the University of Michigan by its College of Architecture and Design. Should the experiment prove successful, plastic pipe for all home plumbing needs could be a foreseeable reality in the house of tomorrow.

Koroseal pipe, laid underground, conducts cold water from the main line to the school building which is a full scale model for a standardized system. The structure serves as a research laboratory for the college, and was designed for utmost durability, expansion, and disassembly. Rigid Koroseal pipe is produced by the B. F. Goodrich Company industrial products division, Akron, O.

Celanese Erecting New Plant

Celanese Corp. of America, New York, N. Y., soon will start construction of a new chemical manufacturing plant at Gallipolis Ferry, W. Va. The new plant, to be built on a 412-acre site, will produce plasticizers for the coatings and plastics industries; fire-retardant hydraulic fluids and compounds for the automotive, aircraft, and other industries; and a range of intermediate products for general industry. Among the products to be made is tricresyl phosphate, developed by Celanese in 1914 and first used as a camphor substitute, but now having broad application in the chemical and plastics fields.

R. W. KixMiller, vice president in charge of the chemical division of the company, has announced a target date of April, 1956, for inauguration of chemical production operations.

Outdoor installations will prevail at the plant, which in general appearance will resemble a typical petroleum refinery with its towers, tanks, and piping.

Establishment of the Gallipolis Ferry operation will accomplish three broad objectives, according to Mr. KixMiller: continue the company's long-range program of active participation in the expansion of chemical markets; permit utilization and upgrading of part of the company's petrochemical raw materials; and improve the Celanese position as a supplier of chemical raw materials to the plastics industry.

Bristol-Myers Acquires Kimball

As part of their program of expansion into the plastics industry, Bristol-Myers Co., the internationally-known pharmaceutical firm of New York, N. Y., has announced the purchase of Kimball Mfg. Corp., San Francisco, Calif. A producer of molded reinforced plastics, Kimball will continue to operate under its present name as a wholly-owned subsidiary.

William Talbot, one of Bristol-Myers research executives, will act as coordinator and liaison officer, and William R. Kimball, Jr., will continue as company president. Bristol recently acquired the Sun Tube Corp., which is engaged in research and development work in the field of plastic tubing.

Emery Opens New Research Labs

A three-story research center providing 30,000 square feet of floor space for 28 individual laboratories has been completed by Emery Industries, Inc., Cincinnati, O. Called the Twitchell Memorial Laboratories, it houses the new chemical, fatty acid and esters, and the textile laboratories, plus the chemical engineering department and pilot plant facilities.

Executive offices, a conference room, and a library have been provided to enable Emery to investigate and evaluate fatty acids, plasticizers, and textile oils in such applications as plastics, cosmetics, paints, rubber, and textiles.

Emery's new Twitchell Memorial Laboratories

Employs Styrofoam Insulation

The flooring of all refrigerated delivery and ice cream truck bodies are being insulated with Styrofoam (Dow Chemical Co.'s expanded polystyrene) at the Herman Body Co., St. Louis, Mo. Herman finds the material particularly suitable due to its high resistance to water vapor transmission, and high compressive strength.

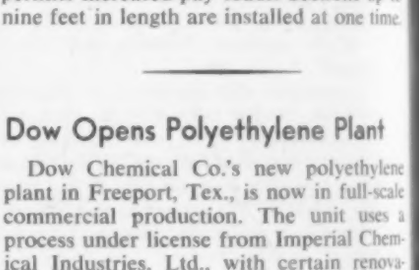
Styrofoam's moisture pick-up is reportedly negligible even when totally immersed for some time. The individually-sealed cells act as natural water barriers, and also serve to retard the passage of heat. Four-inch thicknesses of the material are used in the delivery trucks to help maintain a desired temperature of 40° F., while six inches of thickness are used for the ice cream trucks which operate below 0° F. Six inches of foam are needed for the truck sides.

Weighing only 1½-2 pounds per cubic foot, about one-quarter the weight of corkboard, the foam is easily installed and permits increased pay loads. Sections up to nine feet in length are installed at one time.

Dow Opens Polyethylene Plant

Dow Chemical Co.'s new polyethylene plant in Freeport, Tex., is now in full-scale commercial production. The unit uses a process under license from Imperial Chemical Industries, Ltd., with certain renovations in both the process and the equipment.

Inherent properties of Dow polyethylene reportedly include uniform molecular weight distribution and a granulation of low bulk factor, free flow, constant feed, and outstanding coloring characteristics. Initially, two formulations are available: 900M for injection molding, and PC-51 for extruded pipe. Formulations for film extrusion, blown bottles, wire coating, and paper coating are presently under development.



Dow polyethylene plant in Freeport, Texas

Adams Expands Operations

Acquisition of a four-story building in Holyoke, Mass., is expected to boost the productive capacity of Adams Plastics Co., a subsidiary of Ekco Products Co., Chicago, Ill. The move will give Adams 125,000 square feet of floor space, five times the previous figure, and will increase the number of employes from 100 to approximately 300.

The shift was necessitated by the firm's entry into the plastics houseware field, and by the increased demand for Flint cutlery, which uses Adams' Pakkawood handles. Ekco recently bought the plastics housewares division of Kilgore, Inc., and has assigned this operation to the Holyoke concern. Adams was acquired by Ekco in 1954.

Expands Laboratory Facilities

DeBell & Richardson, Inc., Hazardville, Conn., announced that its plastics research and development laboratories have virtually doubled their available floor space by the firm's purchase of the mill and water power of the adjacent A. W. Dolge Co.

The 20,000 additional square feet of work area will permit the erection of new chemical and engineering laboratories for pilot plant experimentation in the polymer and plastics fields. The firm also offers full-scale manufacturing plant layout and design services.

Applies Vinyl Coating to Metal

Vinyl-clad metal sheets are being produced by Clad-Rex Steel Co., Denver, Colo., at the rate of 4,000 square feet per hour. Intended originally for wainscoating, the sheets are finding application as counter topping, kitchen cabinets, trailer and truck body panels, and as office furniture.

Vinyl is bonded to the metal by the Marvibond process, a development of Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Mass. The coated sheets combine the structural strength of metal with the bright colors and toughness of vinyls, and have a higher abrasion resistance than varnish, paint, or baked enamel finishes. Plastic-coated sheets can be sheared, crimped, bent, drilled, and punched with standard tools without fear of separating the two materials.

At Clad-Rex, metal sheets are coated with a specially formulated, semi-rigid film of Marvinol vinyl resin on virtually a continuous basis. Chemically-clean, etched metal sheets pass along power rollers to the first adhesive-applying machine, where a thin film of adhesive is applied. Infra-red lamps are used to dry the adhesive, and the process is repeated. Vinyl is applied with a roller, using moderate rolling pressure. The finished individual sheets are trimmed to size with a shearing machine.

Plastics Reduce Naval Costs

Increased use of plastics not only bolsters the national defense, but is saving the taxpayer money, according to the Navy's Office of Information in a release to the Manufacturing Chemists' Association, Washington, D. C.

A copolymer of vinylidene chloride and acrylonitrile is being used to coat the insides of fuel tanks for ships and planes, thus enabling them to withstand the corrosive action of aviation gas, sea water, and hot water cleaning sprays. Tanks previously requiring costly repairs after six years of service and rebuilding after 12 years now last indefinitely with the application of a coating every five years.

Recent specifications call for the use of nylon for one type of electrical fitting on all new ships. The fitting forms a watertight seal where an electrical cable enters a fixture or terminal box, and this innovation alone reportedly reduces the weight of a large aircraft carrier by an estimated 30-45 tons. Simplified design and installation are expected to save an average of 50% in intial cost and labor.

Rot-resistant phenolic foams replaces balsa, a highly critical material, for filling blisters. Labor costs are lowered, since the foams do not require cutting to size and shape. Plastic replaces steel in drums for storing bleach, and reinforced plastic tanks can be used for oil and fresh water storage in place of scarce monel and aluminum bronze. Plastic piping, which resists the corrosive effects of sea water, has replaced copper and nickel in a number of instances.

The Navy's Military Sea Transportation Service currently is investigating the feasibility of substituting expanded polystyrene for sheet-metal buoyancy tanks used in life boats. Reinforced plastic life boats are also under consideration.

Nopco to Expand Facilities

Anticipating a tremendous demand for foamed plastics within the next five years, Nopco Chemical Co., Harrison, N. J., has allocated one-million dollars to its newly-created plastics division for expansion of facilities. Nopco pioneered in the development of rigid urethane foams for military and commercial uses in this country, and plans on broadening its plastics activities with both urethane and vinyl foams.

Current estimates show 400,000 pounds of expanded urethanes being produced, and the demand is expected to reach 100,000,000 within the next four years. Present plans call for the completion of two plants this year, each having a productive capacity of 2,000,000 pounds of both urethane and vinyl foams. In addition to the two units, which will be located in New Jersey and in Los Angeles, Calif., Nopco plans yet a third facility at a location as yet unannounced. The New Jersey plant will include a research laboratory and the engineering and applications division, as well as a production unit. The firm already holds licensing agreements with Mobay and Lockheed.

In Brief . . .

Tube Turns Plastics, Inc., Louisville, Ky., has been awarded a plaque by the National Industrial Distributors' Association and the Southern Industrial Distributors' Association for a series of advertisements describing the benefits to be gained by making purchases from industrial distributors.

Great American Industries, Inc., Meriden, Conn., manufacturer of cellular rubber and plastics products in its Rubatex Division, Bedford, Va., has acquired The Colson Corp., Elyria, O., material handling manufacturer.

Marbon Chemical Division of Borg-Warner Corp., Chicago, Ill., has begun preliminary engineering work on its recently-acquired site of land at Washington, W. Va., in anticipation of the locality's future development.

Crystal-X Corp., Lenni Mills, Pa., has designed and built the Magni-velope Automatic, a machine for making very large polyethylene bags, liners, and special protectors. The company can now "mass-produce" containers ranging in size from 9/16 by 1 inch to 40 by 70 inches, with subsequent economies.

Monsanto Chemical Co.'s plastics division, Springfield, Mass., has announced the availability of Opalon #75219, a vinyl chloride extrusion compound featuring the addition of non-migratory plasticizers and a fungicide. The material is recommended for pastel-colored door gaskets for refrigerators with styrene liners.

The Eagle-Picher Co., Cincinnati, O., has purchased Wilson & Hoppe Plastics, Whittier, Calif., manufacturer of laminated plastic products sold under the trade name Lamin-art.

E. I. du Pont de Nemours & Co.'s fabrics division, Wilmington, Del., is producing non-woven felts of Teflon fibers for hot and caustic filter applications. Available in sizes up to 40 inches by four yards and in thicknesses of 1/16-1/2 inch, the felts have a low affinity for water and other materials.

Dow Chemical Co., Midland, Mich., has modified its drum-filling operation to meet Universal Standard Drum Specifications as set up by the Petroleum Packaging Committee and the Steel Shipping Container Institute. The new drums will be of black steel, zinc phosphatized, with 3/4- and two-inch openings in the head. They will contain 410 pounds of monomer, as opposed to the 400 pounds formerly supplied.

News from Abroad

Low Pressure Polyethylene

A method of making polyethylene without the enormous pressure of 1,000 atmospheres required by other processes has been worked out by Professor Karl Ziegler at the Max Planck Institute for Coal Chemistry, Muhlheim-Ruhr, Germany. Apparently, this result is achieved with the aid of aluminum alkyls.

The Farwerke Hoaachst A.G. vorm. Meister Lucius Bruning, Frankfurt a.M.-Hochst, has begun to produce the low pressure polyethylene under the name of Hostalen. Large-scale production is expected by the end of 1955 when the material will be made available to all branches of the plastics industry. This new development reportedly forms part of a long-term project of the Hochst concern, which has provided for the expenditure of 175,000,000 DM to supply its own basic materials. A petroleum-cracking plant is to be set up to serve mainly in the production of new plastics and synthetic fibers.

In addition, this firm has arranged with Deutsche Erdol A.G. and Mannesmann A.G. in the Ruhr district for the joint establishment of a plant for producing polyethylene by the Ziegler method. The Mannesmann company is contemplating the production of plastic piping.

Incidentally, another new product of the Hochst concern is Hostaphan, a polyterephthalic acid ester film.

West German Plastics Boom

The year 1954 was a banner year for plastics production in West Germany. Material output increased 36% over the previous year, reaching a total of about 338,000 tons. Polymerizable materials such as PVC, polyethylene, and polystyrene accounted for a large portion of this advance, yet left a domestic shortage of the latter two items.

Sales of plastic products showed a 30% increase over 1953 figures, and prices were generally stable. Exports gained by more than 50%, with Great Britain and Scandanavia furnishing the largest markets. The most important technological development last year was the announcement of a new process by the Max Planck Institute of Coal Chemistry requiring only normal pressures and temperatures for producing polyethylene with coke oven gases.

The outlook for 1955 is bright, with the main problem remaining capital investment. The West German market for risk capital is still tight, although tax reform and the generally high level of economic activity have eased this situation to some extent. The Plastics Exhibition, to be held in Dusseldorf on October 8-16, should give the industry a chance to display its achievements and attract foreign buyers.

Hot Spraying of Plastics

Among the papers read at a conference held in connection with the 1955 Exhibition of Plastics in Oyonnax, France, on April 28-May 3, was one by M. Raymond, of the Societe Protectal, Grenoble, which dealt with the hot spraying of plastics by a new method which avoids the use of solvents or emulsifiers, relying on heat to liquefy the plastic.

The difference between this and similar processes seems to be that the heating takes place in a receptacle connected with the spray gun. The apparatus used (the spray gun and heater) is available in several designs. A small size which weighs about four pounds, including the heater, uses 400-800 watts per hour, and can cover a surface of about 60 square meters in an hour. It is serviced by the usual type of compressor. Current is supplied by a variable potential transformer. Devices with larger capacities either have a separate reservoir, or consist of multiple spray guns to cover a larger surface at one time.

The sprayed material reaches the surface to be treated at a very low temperature, so that the device can be used for very delicate operations; for instance, to spray products with a melting point of 70 C. over wounds or burns on the human body. It can be used to protect such diverse surfaces as wood, metal, cement, stone, fruits, and cartons. A most promising application is expected to be in the cold molding process, to spray polyesters onto wood or plaster molds to serve as both surface fillers and mold release agents.

In conclusion, M. Raymond revealed that other devices are now being developed with which it will be possible to spray polymerizable materials.

"Transparent Rubber"

On the same occasion, M. Flamant of St. Gobain, Paris, France, dealt with the injection molding of plasticized PVC, particularly of the company's Lucolene M, which is claimed to be exceptionally stable, and available in six plasticity ranges from very soft to semi-rigid. The company has just put on the market a new clear grade of Lucolene which, as the author put it, is a "veritable transparent rubber."

Plastics in the USSR

The USSR is rather niggardly in giving out statistics and other data about the production of plastics within its border, and such information as gets out tends to be general, while the few figures mentioned are usually rough estimates. Hence, it is difficult to get a clear picture of the plastics situation in that country. According to a French source, present consumption of plastics materials in Soviet Russia, including synthetic fibers, synthetic rubber, films, and the like, is about 650,000 metric tons annually, which would be a little over three kilograms per capita.

As elsewhere, prewar production was low and shortages of raw materials kept it low. Other than artificial horn from casein, celluloid, and cellulosic products, not much else besides phenol-formaldehyde resins was made in the line of actual plastics. Total output was estimated at 10,500 tons in 1936 and 14,000 tons in 1938, with the phenolics accounting for about two-thirds of the totals.

It seems that several factories, including most of those producing viscose fibers, were destroyed during the war but have since been rebuilt. In addition, three new factories have been erected since the end of the war, and others are planned or already under construction. A few years ago a research institute was established at Leningrad where the technology of new synthetic fibers, particularly the polyvinyl type, is being studied.

Artificial horn (Galalith), celluloid, cellulose acetate, benzyl acetate, vinyl and polyacrylic resins, aminoplasts, and phenolics are among the materials now being produced. Several firms supply vinyl resins in the form of tubes, welding rods, and sheet. Acrylates are used in the manufacture of safety glass, and it is understood that a new polyacrylonitrile fiber is being produced by a textile combine in Leningrad.

From the available date, it appears that an important production center for plastics is the Moscow area. Plants are also located in the Baltic area, the Ukraine, in and around Odessa, and Leningrad.

Forms Alsynite of Australia

The Alsynite Co. of America, San Diego, Calif., has concluded franchise arrangements with W. J. Manufacturing Co., Ltd., and five other Australian firms to produce and distribute Alsynite translucent fiberglas panels throughout the South Pacific. The new firm will be known as Alsynite of Australia, and has already begun its initial pilot run at a new 10,000-square foot plant in Manly, on the west side of Sydney Harbor.

Production, as initially planned, should amount to 500,000 square feet of the panels per year on one shift. Space is reserved for the construction of new units which would triple this figure. Ultimate plans call for the manufacture of Alsynite's entire line of products. Reinforced plastic panels had not previously been produced in Australia.

Plastics Progress in Italy

Considered against 1954 world production of plastics totaling about 2,332,000 tons, Italy's output of over 56,000 tons in that year does not seem very large. However, this amount has been reached since 1950 when the total was only about 13,000 tons and, therefore, reflects rapidly growing activity in the industry in recent years. The Italian figures for the intervening years were 17,000 tons in 1951, 25,000 tons in 1952, and over 40,000 tons in 1953.

Italian converters, encouraged by the favorable price-level of many domestic plastics which, in some cases, are below the levels prevailing elsewhere, have been able to increase their exports from 1,839 tons in 1951 to 3,563 tons in 1952, 6,451 tons in 1953, and 14,034 tons in 1954. The sudden spurt in 1954 permitted exports for the first time to exceed imports, although these, too, had risen in that year to 9,397 tons. Imports had been 5,086 tons in 1951, 8,537 tons in 1952, and 7,897 tons in 1953.

The chief imports were cellulose acetate and other cellulose ethers and esters as powders, unmodified amine and amide condensation and polycondensation products, and unplasticized thermoplastic polymerization products in the form of powders, blocks, tubes, sheets, etc. The polymerization products constituted the most important export item, amounting to 80% of the total.

Consumption of most plastics also rose considerably during the year. Vinyl resins at 850-900 tons monthly showed an increase of 40% over 1953, with local production covering demand. Incidentally, the price of PVC in Italy is lower than in any other country so that not only consumption but also exports, mostly of semi-finished and finished goods are encouraged.

Consumption of polystyrene at about 5,000 tons was 25% higher than in 1953 and, apparently, is due to go higher. High-impact qualities are made here which, it is claimed, can be used for the same purposes as the American product. During 1954, domestic production of this type of polystyrene had to be eked out by imports, but current production is expected to equal home demand.

The demand for polyethylene doubled in 1954 and was close to 2,000 tons. This demand is expected to be over 3,000 tons this year. Most of the polyethylene is used for making blown film, but in 1954 there was a sharp increase in injection moldings. Very little polyethylene is being extruded as yet in Italy. With regard to low pressure polyethylene, it seems that Montecatini has developed a type with a molecular weight of 100,000-500,000, and the grades with molecular weights over 100,000 are said to be employable at temperatures ranging from —100 to +150° C. and over.

Polymethacrylate for molding is not being produced in Italy, but is imported from the United States or Germany.

A good deal of machinery for the plastics industry is produced in Italy, particularly injection molding machines and extruders. About one-third of the output of these two types of machines is exported.

Third Plastics Exhibition

The Third British Plastics Exhibition, held in London, England, on June 1-11, was a success on all counts, including the number of exhibitors and the variety of products and the attention they drew. More than 120 companies participated, including a large number of the most important in the field. The interest shown by visitors from about 50 countries in every quarter of the globe must have been gratifying to all concerned, particularly to the organizer, British Plastics, and the British Plastics Federation which gave its co-operation.

As to the exhibits, every type of plastic material and product seemed to be on view. Three special exhibits, in particular, helped to give this impression: the full-scale model of a coal mine shown by British Geon, Ltd., to demonstrate the various uses of PVC in this field; the display of Imperial Chemical Industries, Ltd., with its theme, "Plastics in the Home"; and that of British Resin Products, Ltd., with the accent on "Plastics in Transport." At one of the sections of the latter were seen the company's Cellobond brake-lining resins and friction dusts based on cashew nut shell oil resins.

The British Oxygen Co., Ltd., showed applications of polyvinyl acetate which it is now making in granular and emulsion forms at its new factory at Chester-le-Street, County Durham. Rediweld Ltd., which featured polyethylene and PVC products for the chemical industry, displayed a new type of centrifugal pump made from rigid PVC block for conveying acids and corrosive liquids. A Rhovyl Selecta filter paper made from unplasticized PVC fiber for filtering acids and alkalis, was shown in England for the first time.

Vacuum-formed metallized cellulose acetate film was seen at the Utilex, Ltd., exhibit. This material is now available in widths up to 32 inches, and in silver and gold as well as red, green, blue, and amber. Polyethylene-coated papers and boards up to 72 inches wide and Telcothene polyethylene powder applied and fused to metal surfaces as protection against corrosion, mold and fungus, and chemicals were among the products shown by Telegraph Construction & Maintenance Co., Ltd. Several new plasticizers, pigments, and an optical bleaching agent were among the products exhibited by the Geigy Co., Ltd.

New developments in machinery and equipment were shown by several firms, including General Electric Co., Ltd., with an infra-red heating panel three by six feet in size for use in gelling PVC pastes; The Projectile & Engineering Co., with a new fast-cycling injection molding machine, a vacuum forming machine, and a 4½-inch single screw extruder; Radio Heaters, Ltd., with new table-type welders having separate oscillators and presses; and R. H. Windsor, Ltd., showing its RC 100 twin-screw extruder with latest die and take-off technique.

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NAMES in the NEWS

Theodore S. Hodgins, vice president in charge of the Pacific Northwest division of Reichhold Chemicals, Inc., White Plains, N. Y., has been named director of the chemical and rubber division, Business and Defense Services Administration, U. S. Department of Commerce, Washington, D. C., for a term of six months.

John D. Calfee and **William R. Richard** have been appointed section leader and group leader respectively for Monsanto Chemical Co.'s central research department in Dayton, O. **Dr. Calfee** will direct certain phases of polymer research, as will **Dr. Richard.**

Madison Geddes

J. R. Hoover

J. R. Hoover, president of B. F. Goodrich Chemical Co., Cleveland, O., was elected chairman of the board of directors for the Manufacturing Chemists' Association, Inc., succeeding **Fred J. Emmerich.** He was elected a director in 1953, and in 1954 became a member of MCA's executive committee. **William E. Chace** has been named director of education, having formerly served as director of publications.

Fred J. Holzapfel has been named technical services superintendent for Monsanto Chemical Co.'s **John F. Queeny** plant, St. Louis, Mo. **Jack W. Graves** succeeds him at that position with the **William G. Krummrich** plant in Monsanto, Ill.

John H. Lux has been elected president and a director of Haveg Industries, Inc., Marshallton, Del., which was formerly known as Continental-Diamond Fibre Co. Timothy Murphy, former president, will continue as a director and vice chairman of the board. Former vice president in charge of sales for Shea Chemical Corp., **Dr. Lux** will direct the company's manufacture of chemical equipment, corrosion resistant pipes, and plastic raw materials.

Norman A. Skow, director of research for the Synthane Corp., Oaks, Pa., will represent the United States and serve as secretary at the International Organization for Standardization meeting to be held in Paris, July 8-13. Other delegates to the International Organization for Standardization include: **E. E. Ziegler,** Dow Chemical Co.; **William A. Franta,** E. I. du Pont de Nemours & Co., Inc.; **C. Howard Adams,** Monsanto Chemical Co.; **R. K. Witt,** Johns Hopkins University; **E. Y. Wolford,** Koppers Co.; **R. R. Winans,** New York Naval Shipyard; **Robert Burns,** National Research Council; and **G. M. Kline,** National Bureau of Standards, who will serve as chairman of the meeting.

Eugene Allen, senior research chemist at American Cyanamid Co.'s laboratories in Bound Brook, N. J., has been named editor of the Inter-Society Color Council News Letter, succeeding the late **I. H. Godlove.**

John M. Clegg and **Arthur Katchman** have been added to the research and development departments of Hooker Electrochemical Co., Niagara Falls, N. Y., to serve with the organic chemicals and the resins and plastics groups, respectively.

Henry A. Thouron and **Charles S. Maddock** have been named synthetics department general manager and legal department director and general counsel, respectively, of Hercules Powder Co., Wilmington, Del. Elected vice presidents and members of the company's executive committee were **Wyly M. Billing** and **John R. L. Johnson, Jr.,** who are members of the board of directors.

Paul S. Foster has been appointed manager of Dow Chemical Co.'s office in San Francisco, Calif., which services central and northern California, Nevada, and Utah. He has been serving as chemicals sales supervisor for that office since 1950.

Edward C. Burdick, director of Dow Chemical Co.'s patent department for the past 18 years, and widely known as a specialist in the chemical patents field, has retired after 40 years of service. He is succeeded by **William M. Yates,** who has been serving as assistant director.

H. R. Dinges

H. R. Dinges has been appointed general sales manager for Spencer Chemical Co., Kansas City, Mo. He formerly served as industrial sales manager and as assistant general sales manager. **H. E. Bingham,** acting director of product sales, was named general manager of sales services.

R. Lindley Murray was elected chairman of the board of Hooker Electrochemical Co., Niagara Falls, N. Y., succeeding **Edwin R. Bartlett** who resigned to become chairman of the company's newly created finance committee. **Bjarne Klaussen,** former executive vice president, was elected president of the company.

H. A. Voskamp, Jr.

H. A. Voskamp, Jr., has been chosen to direct the newly-formed thermoplastic sales group within Barrett Division, Allied Chemical & Dye Corp., New York, N. Y. Polyethylene lubricants and nylon molding compounds comprise the initial entry, and will appear under the Plaskon trademark.

Paul Zuris has been named mechanical engineering supervisor for Mobay Chemical Co., St. Louis, Mo.

Wallace E. Gordon, assistant director of sales for Grasselli Chemicals Department, E. I. du Pont de Nemours & Co., Wilmington, Del., was named director of advertising. He succeeds **William A. Hart,** who retires after 31 years of service.

Harold Zinnes has been named to the technical division staff of Baker Castor Oil Co., Bayonne, N. J. **Dr. Zinnes** will work on new product development.

Carl L. Beal has been appointed technical consultant and eastern representative for Akron Presform Mold Co., Cuyahoga Falls, O., with headquarters at Kendrick Lane, Huntington, N. Y. The company designs and manufactures rotational plastisol casting machines, molds, forms, and dispensing units for plastisol-dipped articles.

George W. Martin

George W. Martin, former general manager for the plastics division of Noma Lites, Inc., has joined Adams Plastics Co., Inc., Holyoke, Mass., as manager of the molding division. He will primarily direct compression and injection molding activities, two phases of Adams' operations which are undergoing expansion.

Paul Stahlberg has been named technical service manager for the polyethylene resins department of Monsanto Chemical Co.'s plastics division, Springfield, Mass. He has been associated with the polyethylene technical service group since its inception early this year.

Marion E. Teller and **Edward C. Earley** have been appointed managers for the Minneapolis and Cincinnati sales offices, respectively, of Dow Chemical Co., Midland, Mich. Both offices were recently elevated from field to full sales office rank. **Eugene L. Martinez** has been named manager for the prospective Buffalo sales office, which is expected to open late this year. **William F. Hardy** replaces **Mr. Teller** as supervisor of industrial chemical sales for the Chicago office, and **William L. Corbin** succeeds **Mr. Earley** as supervisor of agricultural chemicals sales.

Robert Kenny has been appointed service engineer for Surface Chemicals, Inc., McKees Rocks, Pa., where he will work on a development program for the company's line of specialty coatings.

William C. Foster has resigned as president and director of the Manufacturing Chemists' Association, Inc., after having served as MCA's first full-time president for the past two years. Prior to that time, he had served as deputy secretary of defense and in other government posts.

Norman A. Shepard has retired as chemical director of American Cyanamid Co., New York, N. Y. He had joined the company in 1936 as director of technical service. **Dr. Shepard** is serving the Department of Defense as a member of the Material Panel in the office of the Assistant Secretary of Research and Development, and is a member of the advisory committee on plastics at Princeton University's School of Engineering.

H. R. Thies, general manager of The Goodyear Tire & Rubber Co.'s chemical division, Akron, O., has completed 25 years of service with the company. He joined Goodyear as a rubber researcher in 1930, became assistant director of research in 1936, manager of Pliolite sales in 1942, manager of the plastics and coating department in 1945, and was named to his present post in 1954.

William B. Daume has been named personnel director for Monsanto Chemical Co.'s plastics division, Springfield, Mass.

Frederic F. Bingham has been appointed sales manager of Harmon Colors, B. F. Goodrich Chemical Co., Cleveland, O. He will direct sales operations from the Harmon office in Haledon, N. J. Harmon manufactures pigments and dispersions for use in paints, plastics, printing inks, rubber, and textiles.

A. E. Polson

John Warner

A. E. Polson and **John Warner** have been advanced to manager of the plastics department and assistant manager of the coatings department, respectively, of the chemical division, The Goodyear Tire & Rubber Co., Akron, O. **R. S. Earhart** has been promoted to assistant general sales manager of the division, and **P. S. Sherman** has been promoted to sales operating manager.

George H. Sherrard has been appointed vice president of Cordo Chemical Corp., Norwalk, Conn., manufacturers of synthetic resins for reinforced plastics and coated fabrics. He will continue as sales manager in addition to assuming new administrative duties.

William A. Mitchel has been appointed manager of distributing branches for United States Rubber Co., New York, N. Y., succeeding **Henry G. Noss.** He formerly served as assistant to **Mr. Noss,** who recently retired.

William F. Hering has been appointed engineering estimator for Mobay Chemical Co., St. Louis, Mo. He previously served as estimator and control engineer for Monsanto Chemical Co.'s research and engineering division.

William F. Condon

William F. Condon has been appointed general sales manager for Spun-Lite Corp. with headquarters in Miami, Fla., and New York, N. Y. He previously served as project engineer in the development of reinforced plastics for the aircraft industry.

Walter C. Rueckel has been elected vice president and general manager for the engineering and construction division of Koppers Co., Inc., Pittsburgh, Pa. He will direct all of the division's activities in this country and abroad. **Dr. Rueckel** had previously served with Koppers in various capacities, and most recently was a vice president with Henry J. Kaiser Co.

Thomas H. Reilly has been appointed manager of advertising and sales promotion for General Electric Co., silicone products department, Waterford, N. Y.

A. Judson Wells, assistant research director of E. I. du Pont de Nemours & Co., Inc., and director of Yerkes Research Laboratory, Buffalo, N. Y., has been transferred to Wilmington, Del., where he will devote full time to his work as assistant research director. **Clement W. Theobald,** research manager at the Laboratory, replaces **Dr. Wells** as director. **Frederick W. Gander,** a research supervisor, succeeds **Dr. Theobald.**

Harold B. Putsey has joined the plastics division of the Machinery Sales Co., Vernon, Calif., which is expanding its facilities to handle the Lester-Phoenix line. He formerly served with Kemco Sales & Service.

George O. Morrison has been appointed to the newly-created post of assistant to the general manager of Shawinigan Resins Corp., Springfield, Mass. He previously served as director of research and development for Shawinigan Products Corp., Milltown, N. J.

Allen Leroy Emptage has been appointed head of Interchemical Corp.'s central engineering department in New York, N. Y. Plant engineer for the textile colors division since 1945, he succeeds **Richard G. Knowland,** who established the department in 1948 and who will continue with it on a part-time consulting basis.

H. K. Eckert

John C. Garrels

John C. Garrels has been appointed assistant general manager of manufacturing for Monsanto Chemical Co.'s plastics division, Springfield, Mass. He previously served as production manager. **H. K. Eckert** has been named director of manufacturing for the Texas City, Texas operations. **Carl E. Pfiefer** becomes director of manufacturing at the Springfield plant, and **J. S. Putnam** replaces **Mr. Eckert** as plant manager in Texas City.

Robert K. Mueller, vice president of Monsanto Chemical Co.'s plastics division, Springfield, Mass., has been elected vice president in charge of the manufacturing division of the American Management Association.

Robert M. Parks and **Earl L. Will** have been appointed to the development department, organic chemicals division, Monsanto Chemical Co., St. Louis, Mo. **Mr. Parks** replaces **Walter F. Waychoff,** who has joined the division's sales department.

George S. Taylor has been appointed plastics technical representative for the cellulose products department of Hercules Powder Co., Wilmington, Del., serving the Detroit, Mich., area.

Walter F. Waychoff has been appointed technical sales specialist for Monsanto Chemical Co.'s organic chemical division, St. Louis, Mo. Previously a member of the division's development department, he will work with the plasticizers sales group. **Karl H. Rothe** was named senior engineer for the design section of the firm's research and engineering division. He had been serving as an operating superintendent.

Ernest Nuber has been appointed general field sales manager for The Bristol Co., Waterbury, Conn. He joined the firm's sales engineering department in 1929, and has served as Pacific Coast manager, export manager, and manager of the application engineering department.

Paul Zuris has been appointed mechanical engineering supervisor for Mobay Chemical Co., St. Louis, Mo. He had been serving as group leader in charge of mechanical engineering for Monsanto's organic chemicals division's research department.

W. Samuel Carpenter, III, has been named assistant director of sales for the petroleum chemicals division of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Formerly director of manufacturing for the cellulosics division, he succeeds **M. W. Campbell,** who transfers to the new isocyanates sales section of the elastomers division.

James A. Hughes, former vice president and general manager of Bryant Heater Division, Affiliated Gas Equipment, Inc., has been elected treasurer of Diamond Alkali Co. He succeeds **Arthur W. Crossley,** who has served as treasurer since 1948.

Robert M. Parks and **Earl L. Will** have been appointed to the development department of Monsanto Chemical Co.'s organic chemicals division, St. Louis, Mo. The former will be concerned with plasticizer development, and the latter becomes a member of the intermediates and exploratory chemicals section.

Walter R. Clark

R. M. Wallace

R. Vernon Jones

Walter R. Clark has been appointed assistant sales manager of Phillips Chemical Co., division of Phillips Petroleum Co., Bartlesville, Okla. Formerly market consultant with Phillips' research and development department, he will assist in directing Marlex sales for the recently-created plastics sales division. Other appointments include **R. Vernon Jones** as manager of technical service and development, and **R. M. Wallace** as divisional coordinator and administrative assistant.

Roger Williams has retired as a vice president and member of the executive committee of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. He will retain his position on the board of directors. **Samuel Lenher,** recently appointed a vice president and member of the executive committee, replaces him as adviser on the company's research activities. Earlier this year **Mr. Williams** was awarded the Perkins Medal of the American Section, Society of Chemical Industry, for outstanding contributions to industrial chemical development throughout his 37 years of service with DuPont.

Samuel N. Seely has been appointed sales supervisor in the Los Angeles district for the kinetic chemicals division of E. I. du Pont de Nemours & Co., Inc., Succeeding him as manager of kinetic's export sales section in Wilmington, Del., is **Leonard Waller,** who has served as foreign technical representative in Switzerland and India for the past seven years.

OBITUARY

Fabian Bachrach

Francis J. Stokes

Francis Joseph Stokes

Francis Joseph Stokes, founder and chairman of the board of F. J. Stokes Machine Co., Philadelphia, Pa., died August 1 at Germantown Hospital, after a brief illness.

Born December 24, 1873, he attended Germantown Friends School and Haverford College, graduating from the latter in 1894 with an A.B. degree. After serving for a year as apprentice machinist to Robert Shoomaker, of Philadelphia, he purchased the business and operated it from then on as the F. J. Stokes Machine Co.

In 1896, Mr. Stokes developed the Eureka pharmaceutical tabletting press, the first commercially-successful high-speed tabletter. From this foundation, he was able to build a machinery manufacturing business which now includes automatic pharmaceutical machinery, high-vacuum processing equipment, plastics molding machinery, and powder metal presses.

Mr. Stokes was president of the organization until 1948, when he became chairman of the board, a position which he held until his death. Funeral services were held on August 3 at the Coulter Street Meeting House of the Society of Friends, Germantown, Pa. Mr. Stokes is survived by his wife, Lelia Woodruff Stokes, a daughter, and four sons.

New Materials

Three Advastab Stabilizers

Three new vinyl stabilizers, Advastabs 48-79, X23-74, and X30-15, have been developed by Advance Solvents & Chemical Corp. Physical properties and specifications are quoted as follows:

	Advastab 48-79	X23-74	X30-15
Form	Clear liquid	Clear liquid	Liquid
Composition	Organic cadmium	Barium-cadmium	Organic zinc
Color, G. H.	5	12-15	4-6
Viscosity, cps	———	150-200	400-500
Specific gravity @ 20° C.	1.133	1.075	1.100
Refractive index @ 20° C.	1.553	1.5049	1.5111
Weight, lbs./gal.	9.5	9.0	9.2

Advastab 48-79 was particularly developed for low-cost stabilization of clear hose, where it reportedly imparts heat and light stability, weatherability, and resistance to water absorption. In most other applications it reacts the same as the company's C-77.

Advastab X23-74 is an experimental one-package stabilizer for use with copolymer grade resin, but also effective in straight PVC formulations. It can be used successfully for such operations as calendering, extruding, and plastisol applications.

Advastab X30-15 was developed for low-cost non-sulfur staining applications. Having no stabilizing property in itself, it should always be used with barium or barium-cadmium systems with which it has a synergistic effect. Systems containing zinc may effect a sudden color change to black, and this can be prevented by the addition of epoxy stabilizers in quantity.

Readers' Service Item M-1

Adhesive Vinyl Plastisol

A vinyl plastisol which reportedly provides a strong adhesive bond to metal surface without the need for primers has been marketed by American Resinous Chemicals Co. Designated Arcco C 1035, the material is intended for caulking side-seams of galvanized sewer pipes, and for drum linings and other metal coatings where chemical resistance is required.

Arcco C 1035 is sold as black or clear solutions of varying viscosities. Typical formulations, with viscosity and Shore hardness data, are available through the company.

Readers' Service Item M-2

Chemically Resistant Elastomer

A synthetic elastomer reportedly offering unusual resistance to petroleum and chemical hydraulic fluids has been developed by Monsanto Chemical Co.'s organic chemicals division. Trademarked Vyram, the material is expected to find application in the field of hydraulic packings which are used to seal connections and joints against the loss of hydraulic fluid.

Vyram packing in new equipment will permit a choice of either petroleum or ester-based fluids, and as a replacement packing will permit easy conversion from one fluid to another. An acrylate-type elastomer, it can be fabricated into standard packings and gaskets using conventional rubber processing equipment. In addition to its ability to withstand the swelling action of a wide range of fluids, Vyram is unusually resistant to ozone.

The new material is supplied in black crumbs as a masterbatch of the following composition: polymer, 100 parts; Dixie 5 carbon black, 30 parts; Cabosil silica, 10 parts; and oleic acid, 1 part. A new curing system was developed with lead dioxide as the primary curing agent, and magnesium oxide to eliminate porosity.

A suggested formulation consists of 141 parts masterbatch, three parts stearic acid, 20 parts magnesium oxide, and five parts lead dioxide. Cure is effected at 330° F. in 30-60 minutes. Properties for such a cured product are reported as follows:

Shore A hardness	75
Tensile strength, psi.	1,333
Elongation, %	346
Tear, lbs./in.	178
Compression set, method B, deflection, %	75
Low temperature brittleness, failure, °C.	–15

Readers' Service Item M-3

Vinyl Extrusion Compound

A vinyl chloride extrusion compound containing non-migratory types of plasticizers and a special fungicide has been introduced by Monsanto Chemical Co.'s plastics division, Springfield, Mass. Designated Opalon 75219, the material was developed specifically for profile extrusion and injection molding of parts which come in contact with styrene or lacquer.

A typical application of Opalon 75219 is the extrusion of pastel-colored door gaskets for refrigerator doors having styrene liners. Good resilience is obtained in web-supported gaskets which are bulb-shaped in cross section. The compound is produced with Opalon 300 as the base, and is available in granular form only. Properties are listed as follows:

Specific gravity @ 25° C.	1.39-1.43
Durometer A @ 25° C.	75
Tensile strength, psi., at 25° C.	1,675
Ultimate elongation, %, @ 25° C.	375
Modulus @ 100% elongation, psi., @ 25° C.	800
Flex. temp. T_f (Clash-Berg), ° C.	—20

Readers' Service Item M-4

Vinyl Dispersion Plasticizer

A clear di-octyl adipate plasticizer, which reportedly imparts excellent low-temperature performance to vinyl dispersions and nitrocellulose lacquers, has been introduced by Barrett Division, Allied Chemical & Dye Corp. Called Elastex 60-A, the material is used to best advantage in combination with general-purpose plasticizers such as DOP and DIOP.

Typical properties for Elastex 60-A are reported as follows:

Odor	None
Color, Hazen	15
Molecular weight	370.56
Specific gravity @ 20/20°C	0.928
Pour point, °C	—50
Viscosity, cps, @ 5° C	30
At 25° C	15
At 50° C	7.0
Refractive index	1.4471
Flash point (ASTM D92/52), °F	400
Fire point (ASTM D92/52), °F	444
Acidity as adipic acid, wt. %	0.01
Saponification number	303
Pounds/gal. @ 68°F	7.75

Elastex 60-A also is used in conjunction with pastes and dispersions of PVC to produce plastisols with long shelf-life. The material is available in bulk or drum quantities.

Readers' Service Item M-5

Plastic Detergent Concentrate

A neutral, liquid anti-static detergent for washing plastic articles has been developed by Spix Products Co. Trade-marked Plasti-Kleen, it reportedly reduces overhead in building maintenance by eliminating the necessity of air-drying plastic lighting fixtures before replacement. After washing with Plasti-Kleen, the fixtures can be rubbed dry and replaced immediately without risk of static build-up.

Tests report that fixtures washed with the detergent show no discoloration after 500 hours exposure to ultra-violet light. No other ill effects on the plastic were noticed. A bath of two ounces per gallon of water is recommended. Standard packing is four one-gallon cans to a carton.

Readers' Service Item M-6

Plastisol for Plating Racks

A general-purpose vinyl plastisol for coating plating racks, baskets, and similar materials handling equipment has become available through the Stanley Chemical Co., division of The Stanley Works. Designated as #77X-1921, the new material should be used with a primer such as Stanley #40X-415 or #72X-426A.

Low viscosity factor and rapid drain-off characteristics tend to minimize carry-over and waste. The plastisol will withstand chemicals used in conventional plating operations employing copper, zinc, nickel, and chrome; however, Stanley continues to recommend its #77X-1078 for use with degreasing solvents containing trichlorethylene or perchlorethylene.

Following are a list of specifications and film properties:

Color	Green
Weight per gallon, lbs	9.73
Recommended bake temperature, °F	350-375
Tensile strength, psi	1,700
Tear strength, lbs	174
Durometer hardness	47-52

Readers' Service Item M-7

VANDERBILT
materials for vinyls

VANSTAY C—Provides efficient heat stabilization at low cost in tile formulations.

VANSTAY L—Recommended for maximum light stability and improved natural ageing in all vinyl resin compositions.

VANSTAY HT·VANSTAY S
This combination provides excellent heat protection for vinyl compositions during processing and in service.

VANSTAY R—Clear liquid heat stabilizer for use in vinyl compositions. Effective for viscosity build-up control in plastisols.

VANCIDE 89—Non-metallic fungicide and bactericide effective in vegetable plasticized vinyls.

Our Technical Service Representatives will gladly demonstrate the merits of our materials in your plant and assist in solving production problems.

R. T. VANDERBILT CO., INC.
230 PARK AVE., NEW YORK 17, N.Y.

Thermoplastic Sheet Material

A new thermoplastic sheeting, which reportedly shows twice the flexural strength of methacrylate and five times the abrasion resistance, has been introduced by The Homalite Corp. Called Dura-lite, the material resists crazing, is readily formable and machinable, and shows immunity to most corrosive chemicals.

Dura-lite is said to be suitable for all types of glazing, especially for television, clock faces, and formed instrument panels and dials for countless industrial, military, aviation, and electronic applications. Properties are reported as follows:

Specific gravity @ 25° C	1.22
Tensile strength, psi	9,200
Flexural strength, psi	30,000
Modulus, 10^5 psi	3.2
Impact strength: Notched Izod	0.4
Unnotched Izod	5.9
Heat distortion, °C., 10 mils	67
Water absorption, 24 hrs. @ 25° C., %	0.2
Crazing, LP-406A	None

Dura-lite is manufactured in standard sheets 1/16-, 3/32-, 1/8-, 3/16-, and 1/4-inch thick; sheet sizes range up to 40 by 50 inches. Special sizes may be cast or cut to specifications when ordered in sufficient quantities.

Readers' Service Item M-8

Opalon Vinyl Wire Insulators

Three new vinyl compounds for wire and cable insulation, Opalon 1038, 72254, and 72217, have been introduced by Monsanto Chemical Co., plastics division. Opalon 1038 is a primary insulation compound approved by Underwriters' Laboratories for Type T and TW uses and exposure to oil at 60° C., and is particularly suited for manufacture of large-size building wire and UF-NMC cable, with long retention of its flexibility, according to the company.

Opalon 72254 is reported to be a general-purpose, flame-retardant jacketing compound, recommended for sheathing applications requiring good physical properties, flame retardancy, —40° C. low temperature performance, and weatherability, and is especially suited for REA telephone cables and products meeting ASTM-D-1047. Opalon 72217 is said to incorporate high shear strength, flame retardancy, and high resistance to tearing, and is especially practical for switchboard cable jacketing and inside telephone wire jacketing.

Some typical physical properties of the three compounds have been reported as follows:

	Opalon 1038	Opalon 72254	Opalon 72217
Specific gravity, @ 23° C	1.37	1.41	1.39
Hardness, Durometer A, @ 23° C	89	87	87
Tensile strength, psi., @ 23° C.	2550	2360	2360
Ultimate elongation, %, @ 23° C	310	334	334
Modulus, @ 100% elongation, psi.	1610	1320	1320

Readers' Service Item M-9

New Equipment

High Shear Viscometer

A high shear viscometer for testing the flow properties of pigment suspensions in the manufacture of paper, plastics, paints, and printing inks has been developed by Hagan Corp. Offering a new approach in the design of rotational viscometers, the instrument employs a pneumatic system instead of springs for measuring and recording the shear force in terms of torque.

Substantially free from mechanical hysteresis, the viscometer operates on the basic principle of measuring an unknown force by supplying a known counterbalancing force. Both torque developed by viscous drag and rate of shear are recorded by the meter's ring balance gage.

Linear and sensitive in operation, the viscometer has a high speed low range starting response. The variable speed transmission is driven by a constant-speed motor, the sample cup is stationary, and the bob is hand operated. The value of output air pressure is verified in terms of dyne-centimeters of torque. Range of torque may be varied from 1-10 by adjusting the mechanical coupling of the sample cup.

When the speed of the bob is set and the machine in operation, the gage pen moves radially in linear proportion to the torque and the angular movement of the chart is linearly proportional to the rate of shear. The same crank handle which changes the bob speed rotates the chart plate, thus automatically plotting a rheogram. Maximum rate of shear is 9,000 reciprocal seconds, at which a minimum viscosity of 0.3 poise and a maximum of 12 can be measured. Repeated determinations show the viscometer to be accurate within 1%.

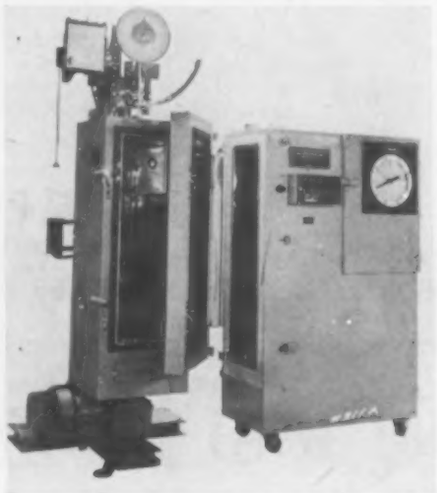
Hagan high shear viscometer

Readers' Service Item E-1

Tensile Tester for Elastomers

An instrument for determining modulus in tension, tensile strength, percent elongation, and tear resistance of elastomeric materials at temperatures ranging from −70 to +550° F., has been introduced by Scott Testers, Inc. Designated the L-8 Hot-Cold Tester, it consists of a basic test unit and a conditioning unit.

The test chamber has the long stroke and quick-return features of the Model L series Scott rubber testers. It can be equipped with a simple pendulum-type weighing system or with the Scott Accr-O-Meter which registers electronically. The unit can be supplied with one rate of pull, with a set number of specific rates of pull, or



Scott L-8 Hot-Cold Tensile Tester

with completely variable rates over a wide range of speeds.

The chamber is lined with stainless steel for visibility and heat distribution. The walls have four inches of insulation, with no metal-to-metal contact between the lining and the metal-clad outside frame. An insulated glass-panel door insures complete visibility of the pulling clamp throughout its stroke, and insulated gloves are suitably located for manipulating the specimen.

Upper and lower ports allow connection either to the Scott conditioning unit or to the user's own system. These ports measure 6 by 12 inches, are 45 inches apart, and are 22 inches above the floor. They permit direct coupling with the test chamber, or may be connected by angle ducts. The Scott conditioner is equipped with 6,000 watts of electrical heating capacity, and with cooling coils and dry ice chamber. Operable manually or by automatic controls, the unit records temperature readings by means of a Brown Recorder. The heaters require either a single- or three-phase, 220-volt circuit. The circulating fan, recorder, and automatic controls need a 110-volt, 60-cycle, single-phase circuit.

A conditioning unit for high temperatures only is also available. Space required for the test chamber mounted on tester frame is 40 inches wide by 42 inches deep by 109 inches high with ORR pendulum head. Other weighing systems require less height.

Readers' Service Item E-2

Whitlock Vacu-Magic Model 3242 automatic vacuum former

Automatic Vacuum Former

An automatic vacuum forming machine, reportedly the first to handle all sizes and requirements at a high production rate, has been developed by The Whitlock Co. Called the Vacu-Magic Model 3242, it features two adjacent operating stations so that the sheet in process is not removed from the oven area before the vacuum is pulled.

The basic machine has a vacuum drawing area of 31 by 41 inches. Sheets up to 60 by 90 inches can be run by attaching alternate tables and ovens. Independent controls permit different jobs to be run at each end. The Whitlock unit will drape independently, and mold time is independently controlled to form different shapes.

Oven travel is power operated and adjustable in speed; fast positioning insures even heating of thin materials. A special valving arrangement admits a rush of filtered air to the back side of the plastic at the moment of release, reducing the possibility of distortion when the plastic form is removed from the mold. A safety limit control prevents the oven from overheating.

A ½-hp, 9.3-CFM vacuum pump and 30-gallon reserve tank are mounted within the machine. The pump provides for 25 inches of mercury operating vacuum. Gage and switch control are mounted on the front panel. An air compressor consisting of an integral pump motor and filter system is listed as optional equipment.

The travel of the drape action may be set at any desired height above the table up to 11½ inches. In addition, the oven

height is adjustable, allowing the heater to be kept at an optimum distance from the sheet regardless of drape depth. A fume exhaust blower is provided to carry off fumes.

Readers' Service Item E-3

Thermoplastic Heat Regulator

A pyrometrically controlled, fully automatic temperature controller for thermoplastic molding has been introduced by the Industrial Mfg. Corp. Designated the Model H Thermolator, the machine adds or removes heat from the circulating water by remote control, thus saving valuable floor space.

West Instrument Co. built the control center which incorporates all of the controls for the process, with the exception of pressure. The "Thermolator" part consists of a sub-panel with the necessary electrical components mounted in the cabinet (see accompanying illustration). West's Gardsman controllers with pilots, auxiliary switches, and motor starter are affixed to the door. Used in conjunction with a Lester 20-ounce injection molding machine at Plastic Molded Products Co., the machine unit is suspended from the ceiling above the press with piping to a convenient location near the platens.

The controls include nozzle heater, three timers, two mold temperature controls, and electrical components for maintaining five heating zones. The cabinet is 60 inches high, 44 inches wide, and 12 inches deep. A three-position controller has two separate relays, with their control bands separated by a neutral off-zone. This permits the instruments to "float" in between, with subsequent savings in the amount of electrical power required for continuous heating.

Readers' Service Item E-4

Automatic Printer-Packager

Automatic imprinting on heat-sealed plastic film or paper is reportedly accomplished with a minimum of effort using the new Packmaster machine equipped with a Markem Model 76A printer. Known as the Packmaster Model 50, the machine forms, fills, imprints, and counts packages from three by two inches to six by six inches at rates from 40-80 per minute, depending on the material used and the object being packaged.

An economy directed development, the machine achieves additional flexibility through the use of Markem masterplates, typebars, and rubber printing plates which can be changed according to the imprint requirements. Automatic synchronization of the printing head with the variable feed assures exact registration and durable imprints. Finished packages are fed out in a die-cut ribbon, and are easily separated into individual packages. Accordion-folding

Packmaster automatic packager incorporates imprinting in single operation

is equally simple. Approximate size of the entire unit, including the printer at the rear of the rolls, can be determined from the accompanying illustration. Complete information is available through Packmasters Co., manufacturers of the model unit.

Readers' Service Item E-5

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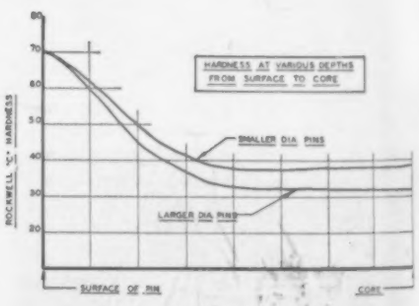

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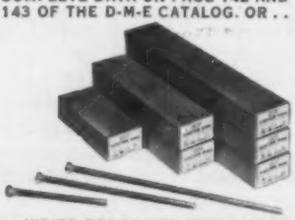

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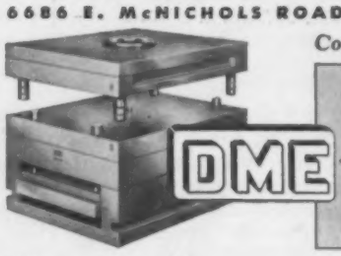

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LOS ANGELES 7, CAL. 3700 SOUTH MAIN STREET, ADAMS 3-8214

3355

New Products

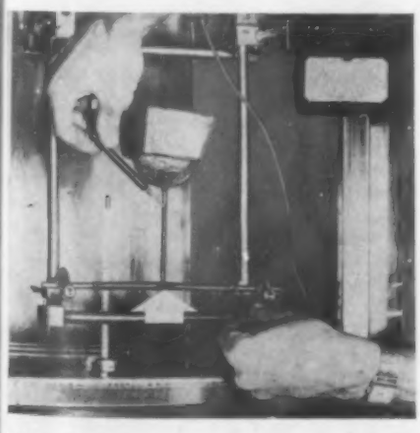
Vinyl Insulation Sleeving

A vinyl sleeving reportedly possessing excellent resistance to oil, varnish, pitch, and abrasion has been introduced by Resin Industries, Inc. Known as Resinite Superheat 125, the tubing is compounded specifically for flexibility, cut-through resistance, and dielectric strength after prolonged immersions in the aforementioned mediums, and at temperatures ranging from −40 to +105° C.

As shown in the accompanying illustration, Resinite tubing successfully resists cut-through by a #17 AWG enameled wire loaded to 300 psi., at 105° C. for 30 days. Other properties are as follows:

Tensile strength, psi	3,700
Elongation, %	320
Ultimate elongation loss, % after 14 days @ 130° C	1.0
Linear shrinkage, %: after 73 hrs. @ 100° C	1.3
After oil immersion for 2 hrs. @ 105° C	None
Flammability	None
Dielectric strength, volts/mil	1,000
Water absorption after 24 hrs. @ 72° F., %	0.1

The tubing shows a maximum loss in dielectric strength of 8% after exposure to asphalt-base impregnating compound at 200° C., and remains flexible after being dipped in varnish and baked for 12 hours at 120° C. Standard sizes from 0.018-2.0 inch ID are available, with corresponding wall thicknesses for both 300- and 600-volt ratings.



Resinite vinyl sleeving subjected to cut-through resistance test

Readers' Service Item P-1

Tenite Polyethylene Lunch Box

An unbreakable polyethylene lunch box with flexible handle and hinged cover and closures is available from Dapol Plastics, Inc. Designated the D-86 Jr., it is light in weight, odorless, and easy to clean. D-86 is intended primarily for children, and is marketed in bright, two-tone colors.

The box itself measures 9 by 7¼ inches, and is 3¾ inches deep. Another model, D-186, has plastic shoulder straps, and both boxes find added use for carrying first aid supplies and picnic food. Tenite polyethylene is supplied by Eastman Chemical Products, Inc.

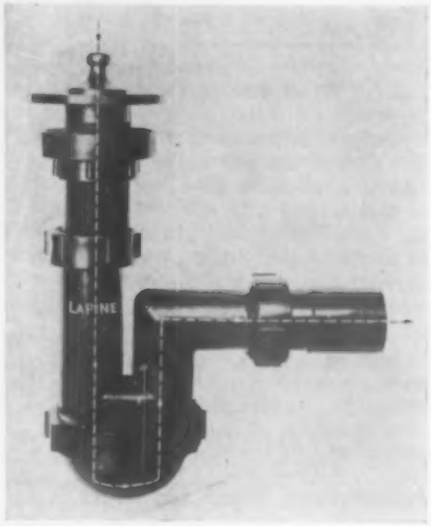
All-polyethylene lunch box

Readers' Service Item P-2

Polyethylene Sink Trap

A polyethylene sink trap, modeled after conventional metal traps with one surface of all pipes visible from the exterior, has been devised by Arthur S. LaPine & Co. Called the P-type trap, it reportedly differs in this respect from the earlier S-type plastic traps in which sewer gases or refuse could by-pass a damaged or partially-hidden outflow pipe.

The new model provides a positive seal at all times, while retaining all the advantages of earlier polyethylene traps: chemical resistance, toughness, flexibility, and ease of installation. A 1½-inch NPS pipe on the outlet union accommodates insert adaptors for connection to standard American-size polyethylene pipe, and a cup-type lock nut permits its use on metal sinks as thin as 16 gage, or on 1⅞-inch stone and ceramic sinks.



LaPine's P-type polyethylene sink trap

A union nut connects the trap to the outflow pipe. This eliminates the necessity of turning the entire trap during installation, which might disturb the drain pipe connection. A strainer and stopper are included with each unit.

Readers' Service Item P-3

Plastic-Overlaid Plywood

A new construction material consisting of exterior-grade Douglas fir plywood faced with phenolic resin has been introduced on the market. The plastic overlay, called Crezon, is supplied by Crown Zellerbach Corp. to plywood mills where it is bonded to the plywood under intense heat and pressure to produce a tough, smooth, weather-resistant product.

Crezon Fused Plywood can be worked with conventional woodworking tools and equipment, and reportedly takes paint far better than wood. Tests conducted by the National Bureau of Standards under extreme temperature and humidity conditions show no checking, cracking, or de-lamination.The material shows none of the edge-splintering, grain-raise, and paint show-

Alternate sheets of Crezon and plywood stacked prior to pressing.

through which is characteristic of ordinary plywood.

Crezon itself is made by pressing cellulose fibers to a thickness of 0.014-inch and adding a phenolic glue-line. The overlay is then wound into rolls for shipment to the mills. The finished product is available in four by eight-foot lengths, and in thicknesses of ½, ¾, and 5/16-inch. Some plywood manufacturers offer lap-sidings precut to 12-, 16-, and 24-inch widths.

Readers' Service Item P-4

Polystyrene Light Diffusers

Polystyrene shields for fluorescent lighting fixtures, reportedly capable of light transmission values up to 70%, have been introduced by Sheffield Plastics, Inc. Consisting of lightweight extrusions, the shields have a lustrous surface finish which is said to be capable of hiding the light-source silhouette completely when assembled at a distance of one or more inches from the fluorescent tube.

Designated DG-70, the new material achieves its high light-transmission characteristics by controlled light refraction. It is further reported that light transmission values can be varied to conform to a wide range of specifications. The shields give off a blue-white color which closely resembles a daylight hue with respect to both transmitted and reflected light.

Red light also is diffused effectively, thus providing diffusers with maximum hiding power over the entire spectrum range. Pink glow, which is characteristic of conventional styrene shields, is eliminated. Exhaustive tests have shown DG-70 to possess impact strength equal to or better than high-quality polystyrene.

Readers' Service Item P-5

Vinyl-foam lined nylon jacket

Vinyl Foam Lined Jacket, Vest

An outdoor-wear jacket and a vest, employing an inner liner of expanded vinyl foam that insulates against cold and wind and is buoyant enough to float the wearer, have been placed on the market by United States Rubber Co. The jacket, called Insulair Vagabond Jacket, has a nylon exterior and a mouton collar, and is available in navy, charcoal, red, and brown colors. The vest, called Insulair Warmster Vest, has a cast vinyl exterior, and is available in red or black.

Readers' Service Item P-6

Reinforced Plastic Pipe

Fibrous glass-reinforced Plaskon polyester pipe, fittings, and valves are being produced by Ed Conley Plastic Corp. for use in the oil and chemical industries. Selected for its corrosion resistance, non-conductivity, strength, and light weight, the plastic pipe has reportedly been giving satisfactory performance in oil fields for salt water disposal, tank batteries, sour crude gathering lines, and gas transmission.

The pipe and fittings are molded in matched metal dies, using glass fibers and Plaskons 941 and 9600, products of the Barrett Division, Allied Chemical & Dye Corp. Conley pipe may be threaded with a hand pipe die, and the fittings are available with standard threads or with deep sockets for resin bonding to unthreaded pipe.

Screwed fittings are said to have shear strengths of over 20,000 psi. Long, precision-molded threading insures tight joints, and extra bands extend beyond the last thread to provide reinforcement at points of severe strain. Socket-weld fittings are available in standard I.D. sizes. A two-inch coupling weighs six ounces, has a bursting pressure of 1,500 psi., and a working pressure of 150 psi.

Raw materials and the completed reinforced plastic fitting.

Readers' Service Item P-7

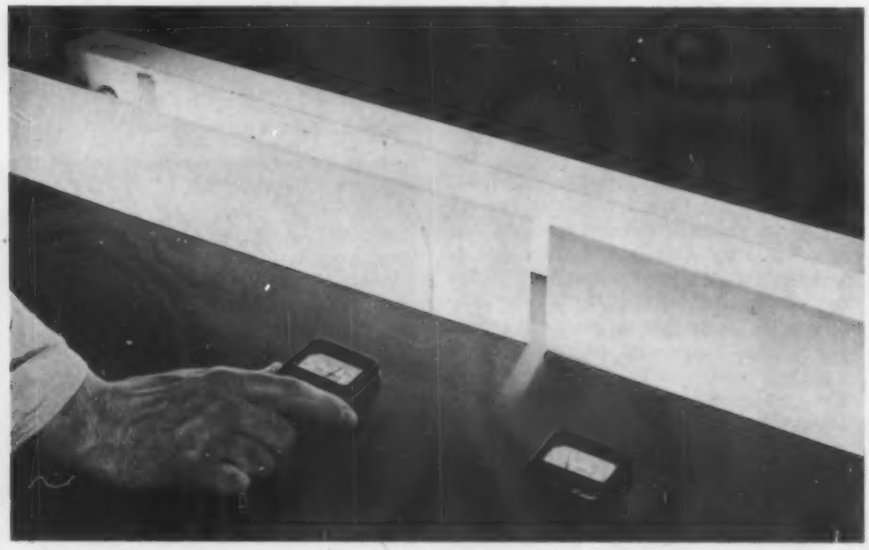
New Hungerford vinyl hand grip

All-Vinyl Plastic Hand Grip

An injection molded, all-vinyl hand grip for bicycles, hand tools, lawn mowers, and numerous other applications, has been introduced by Hungerford Plastics Corp. Designated as Model E, the grip features such original designing as concentric circles on the outer surface for surer gripping, and a shock-absorbing inner core.

Corrosion-resistant, the grip will not stain or discolor hands and clothing. Model E grip is made for ⅞-, ¾-, and ⅝-inch bars, and is available in eight standard colors. Ohio Rubber Co., a division of Eagle-Picher Co., are sole distributors for Hungerford's line of vinyl grips.

Readers' Service Item P-8



Meters record 50% more light with DG-70 shields than with conventional polystyrene

New Literature

"Reagent Price List." Dajac Laboratories. 4 pages. A new and enlarged catalog listing over 100 chemical reagents and their analytical use.

Readers' Service Item L-1

"Butyl Carbitol." F-8636. Carbide & Carbon Chemicals Co. 4 pages. A solvent for nitrocellulose and other resins, the material's physical properties, specifications, solvent properties, and suggested uses are described in this brochure.

Readers' Service Item L-2

"Tenite Polyethylene." Eastman Chemical Products, Inc. 4 pages. Applications of the company's product are covered in this illustrated flyer, along with a general description of the material's moldability.

Readers' Service Item L-3

"Four Basic Plant Types for Synthesizing Ammonia." M. W. Kellogg Co. 12 pages. The booklet describes the company's four set-ups for conversion and purification: steam methane reforming under pressure; catalytic partial oxidation using gaseous hydrocarbons; non-catalytic partial oxidation using natural gases or residual fuel oils; and low-temperature raw gas separation using high hydrogen content feed gases without reforming or partial oxidation.

Readers' Service Item L-4

"Citroflex Plasticizers." Technical Bulletin No. 31. Chas. Pfizer & Co., Inc. 12 pages. Physical properties, formulas, specifications, compatibility, and performance of the company's five citric acid ester plasticizers are tabulated in this bulletin.

Readers' Service Item L-5

"Inserts for SPI Uniform Accounting Manual." The Society of the Plastics Industry, Inc. 4 pages. The first sheet includes a preface and a list of members of the accounting committee. The second sheet describes depreciation, and gives a table of normal depreciation rates.

Readers' Service Item L-6

Publications of Celanese Corp. of America:

"Celanese PVA Copolymer Emulsion CL-202 for Latex Paints." Bulletin NP-14. 15 pages. Properties, formulations, performance, and test methods are given, along with production and handling problems. A listing of raw materials by trade names is included.

Readers' Service Item L-7

"Celanese PVA Emulsion CL-100 for Latex Paints." Bulletin NP-12. 12 pages. Properties of the emulsion and the finished paints are given, together with typical formulations and production methods. Raw materials are listed by trade name.

Readers' Service Item L-8

"Supplement to Bulletin NP-12." 7 pages. Improved formulations and performance data are outlined in this supplementary bulletin.

Readers' Service Item L-9

"Current Status of Polyethylene Sheet Material." Bulletin NP-13. 6 pages. This bulletin deals with 0.015-0.125 gage inclusive, giving information on current and suggested uses for heavy-gage polyethylene. Properties and chemical resistance are given, and a list of polyethylene sheet jobbers is included.

Readers' Service Item L-10

"B. F. Goodrich Food-Handling Conveyor Belts." B. F. Goodrich Co., Industrial Products Division. 4 pages. Properties, specifications, and splicing procedures for white and tan Koroseal conveyor belts are given in this bulletin. Suggestions as to belt surface and number of plies are included.

Readers' Service Item L-11

"1955 Annual Report." Manufacturing Chemists Association, Inc. 57 pages. This annual report of the board of directors covers activities in such fields as legislation, research, safety, statistics, precautionary labeling, chemicals in food, international trade and tariff, industrial relations, plastics, packaging, and standards.

Readers' Service Item L-12

"Chemical Market Abstracts Annual Index." Foster D. Snell, Inc. This index of market news and statistics for the chemical industry during 1954 covers such major subjects as company names, foreign countries, trade marks, and industrial uses of chemicals, as well as domestic and foreign patents.

Readers' Service Item L-13

"Plastics Molding Methods." Auburn Button Works. 8 pages. This illustrated brochure describes the equipment used by Auburn to produce parts by compression and injection, automatic rotary, and Stokes automatic molding, and by extrusion. Typical parts produced by these methods are shown, and some idea is given as to the finishing operations.

Readers' Service Item L-14

"Chemical Plants Division." Bulletin No. 2505. Blaw-Knox Co. 4 pages. This bulletin outlines the division's services from preliminary surveys to process plant operation. Past clients are listed within their fields of specialization.

Readers' Service Item L-15

"Fiberglas Reinforced Molding Compounds." Owens-Corning Fiberglas Corp. 24 pages. This folder contains a number of application case histories, plus specification sheets from Barrett, Cyanamid, Thermaflow, and Fiberite. Intended as a fact file on Fiberglas-reinforced molding compounds, the folder will be kept "up to date" with regularly-scheduled mailings by Owens-Corning.

Readers' Service Item L-16

"Enjay Laboratories Technical Service." Enjay Co., Inc. A 14-page booklet in color illustrating and describing the new technical and sales service laboratories which were officially opened by Enjay in June 1955.

Readers' Service Item L-17

"Isothane." Surface Chemicals, Inc. 4 pages. Properties and applications of this polyurethane foam as thermal insulation and as an acoustic material are given in this bulletin.

Readers' Service Item L-18

"Laminac Polyester Resins," American Cyanamid Co. 43 pages. A series of technical data sheets covering the firm's line of polyester resins. Property data, applications, curing characteristics, and formulations are given.

Readers' Service Item L-19

Book Reviews

"Plastics in Building." Building Research Institute, Division of Engineering and Industrial Research, National Academy of Sciences and National Research Council, 2101 Constitution Ave., Washington 25, D. C. Cloth, 8½ by 11¼ inches, 159 pages. Price, $5.00.

A report on the uses of plastics in the building industry, the book consists of compiled and edited papers presented at the conference on Plastics in Building, conducted by the Building Research Institute in Washington, D. C., October 27-28, 1954. Well illustrated with charts, graphs, and photographs of applications, the text includes 15 papers by recognized authorities in the field, plus an appendix on building code regulations and a report on sprayed plastic sheetings.

Correlated papers are grouped together in five sections. These include a general discussion of plastics as building materials; specific applications; standards and codes; future potential; and a summary of the conference. The section on applications covers light-transmitting panels, glazing and interior illumination, thermal insulation and vapor seals, structural panels, piping, and decorative uses. A question-and-answer discussion follows each individual presentation.

"High Energy Radiation of Polymers, A Literature Review." Office of Technical Services, United States Department of Commerce, Washington 25, D. C. Paper, 15 pages. Price, 50¢.

The available literature on irradiation's effect on physical properties of polymers is appraised and summarized. Significant results have been achieved with polyethylene, according to the various sources, and irradiated material has been shown to withstand temperatures in excess of 250° C. Techniques for treating the various elastomers are also outlined.

"How to Buy Custom Molded Plastics." The Society of the Plastics Industry, Inc., 67 W. 44th St., New York, N. Y. Paper, 8½ by 11 inches, 6 pages. Price, 12-20¢ depending on quantity.

Compiled by the Molders' Management division and the Accounting and Financial Committee of the Society, this booklet is designed to acquaint purchasing agents having occasion to buy plastics parts with some of the do's and don't's of efficiently purchasing custom molded plastics. An inquiry form is enclosed.

"Dielectric Behavior and Structure." Charles Phelps Smyth. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Cloth, 6¼ by 9½ inches, 451 pages. Price, $9.00.

The stated, overall purpose of the work is to explain the relationship between the molecular structure of matter and its dielectric behavior, using experimental measurements of dielectric constant and loss, and electric dipole moment. Highly theoretical in nature, the book should be of considerable interest to research chemists, physicists, and engineers.

Fundamental theories are discussed in the first two chapters, and results of experiments with a large number of liquids and solids are described in detail. Of particular interest to the plastics industry is the section on dielectric constants and losses in high polymers, which include vinyls, polystyrenes, and cross-linked phenolic resins. The use of dipole moment in the determination of molecular structure and the nature of the chemical bond, resonance, and intramolecular energy is discussed at length.

"1954 Supplement to the Book of ASTM Standards Including Tentatives — Part 6: Rubber, Plastics, Electrical Insulation." American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Paper, 6 by 9 inches, 527 pages. Price, $3.50.

This supplement to the original 1952 edition and the 1953 supplement thereof includes 82 pages devoted to plastic standards and test methods, and an additional 17 pages on general test methods and definition of terms used. Test methods listed for plastics are as follows: impact-brittleness temperature; impact resistance; tensile strength of sheets and films; resistance to surface abrasion; molding index of thermosetting materials; light diffusion; luminous reflectance and color; water absorption; and specifications for thermosetting laminates.

"The Chemical Industry Facts Book." Manufacturing Chemists' Association, Inc., 1625 Eye St., N. W., Washington, D. C. Paper, 6 by 9 inches, 160 pages. Price, $1.00; discounts for quantities.

This second edition offers 52 more pages of data than the 1953 Facts Book. Topics covered include the growth of the chemical industry, how it operates, and the role of chemicals in everyday life. Profusely illustrated with charts, graphs, and tables, the booklet is intended to serve educators, analysts, students, and others requiring detailed, accurate information about the chemical industry. The index includes numerous references to plastics, both general and specific. A listing of trade associations and professional societies connected with chemical manufacturing is contained in the appendix.

"Manual of Excellent Managements." American Institute of Management, 125 E. 38th St., New York, N. Y. Cloth, 8½ by 11¼ inches, 160 pages. Price, $20.

A report based on the second annual survey by the American Institute of Management, the book gives ratings of excellently-managed companies with respect to economic function, corporate structure, earnings, service to stockholders, research and development, directorate analysis, fiscal policies, production efficiency, sales vigor, and executive evaluation. Listings are alphabetical, by location, and by industry.

"Plastics—The Story of an Industry." The Society of the Plastics Industry, Inc., 67 W. 44th St., New York, N. Y. Paper, 7½ by 10¼ inches, 40 pages. Price, 30¢; discounts for quantities.

Easily read and well-illustrated, this booklet gives a brief history of the plastics industry, and describes each plastic material with respect to properties, typical end-uses, forms and methods of forming, and lists producers and trade names. Molding, casting, reinforcing, laminating, extruding, and other processing techniques are outlined and illustrated in clear, concise fashion. Opportunities in plastics are explored, and a listing of colleges and universities offering courses in plastics is also included.

"Shelf Life of Liquids in Polyethylene Bottles." PB 111546. Wright Air Development Center. OTS, U. S. Department of Commerce, Washington, D. C. Paper, 8 by 10¾ inches, 127 pages. Price, $3.25.

This Air Force research report was conducted by the Plax Corp., to serve as a guide for the packaging engineer. Eighty materials were tested, packaged in polyethylene bottles which ranged in size from 32 ounces to 13 gallons. Tabulations include such data as 365-day weight changes and test materials included both organic and inorganic acids alkalies, alcohols, esters, aldehydes, ketones, anhydrides, terpenes, nitrogen comopounds, aliphatic hydrocarbons, aromatic hydrocarbons, and chlorinated hydrocarbons.

Temperatures varying from 32-165° F., were used during testing and permeability factors were noted. The report also describes the physical effect of the materials on polyethylene, and chemical changes in the materials themselves. Liquid and vapor phases, as well as the molecular weights of the materials are discussed.

Abstracts of Important Articles

MATERIALS

"Permeability of Plastics," G. Fabre, *Ind. Plastiques Mod.*, 7, 4, 33; 7, 5, 41; and 7, 6, 35 (Apr., May & June 1955).

With the growing interest in plastics for packaging, permeability of films to gases and vapors becomes important. Since so many different factors affect permeability and testing methods vary, widely divergent results are often obtained by different investigators for a product having one generic name. This is illustrated by several tables. The mechanics of the diffusion of gases and vapors through plastics, the effects of molecular structure and arrangement, copolymerization, compactness of the molecule, and unsaturation, as well as the action of various physical and mechanical factors, are considered and illustrated by tables and graphs. The author points out the directions testing must take to increase knowledge of permeability, and concludes that methods must be unified to permit comparable results to be obtained. (In French).

"Tests for PCV Sheeting and PVC-coated Fabrics," J. H. Dawson, *Brit. Plastics*, 28, 6, 243 (June 1955).

This is a survey, in general terms, of tests on thickness, modulus, tensile strength, tear, bursting and seam strength, ply and coating adhesion, bleeding and staining, print adhesion, dimensional stability, fastness to light, flex-cracking, low temperature properties, and abrasion. American and British practice is occasionally compared.

"Where do the Techniques of Employing Organic Glasses Stand?" C. R. Schmid and L. Le Marrec, *Ind. Plastiques Mod.*, 7, 3, 13 and 7, 4, 7 (March-April, 1955).

In this consideration of organic glasses, reference is made particularly to their use in optics. Methods of production, particularly by casting, and of improving properties are discussed and results of various comparative tests on organic and mineral glasses are given. (In French).

"The Position of the Polyacrylates among Thermoplastics." C. T. Kautter, *Kunststoffe*, 45, 4, 131 (April, 1955).

The properties of polyacrylates and polymethacrylates are compared with those of other plastics in similar applications with a view to easing the difficulties of selection for the processor and consumer. (In German).

"Recent Developments in the Curing of Epoxide Resins," E. S. Narracott, *Brit. Plastics*, 28, 6, 253 (June 1955).

New methods involving the combination of epoxide resins with a variety of other materials are summarized, among them the use of amine adducts and amine salts. The precondensation method of modifying epoxide resins developed in the Shell laboratories in Amsterdam, Holland, is illustrated by a description of precondensation with methylene diamine, and of Epikote 1007 with Synreseen 373 U (a Dutch phenol-formaldehyde resin), among others. Development work in Europe with phenolic molding powders is referred to, and recent results with "epoxy alloys."

"The Technology of Foams," J. A. Carr and B. B. Williams, *Canad. Plastics*, 41 (April 1955).

A brief review of the methods of manufacturing various rigid and flexible foams serves as introduction to the body of the article dealing with three particularly promising flexible foams: foamed latex, vinyl foam and sponge, and polyurethane foam. The processes employed in their production, properties, and market potentials, uses, and costs are compared. Because of the difference in their properties, thre is room for all three foams, but keen competition is expected in certain areas of use.

"New Physical Research Methods in the Domain of the Macromolecules," M. Piganiol *Ind. Plastiques Mod.* 7, 3, 32, and 7, 4, 39 (March-April, 1955).

The methods discussed include, among others, infra-red techniques (on polyethylene); nuclear resonance (specially mentioned as one of the newest and most interesting); and apparatus for determining mechanical properties, such as the Ephimeter (for simultaneously measuring elastic modulus and internal friction at variable temperatures and frequencies), the Universal Consistometer, the tonometer, and the microcalorimeter. (In French).

Requests for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines will be printed here quarterly.
—The Editor

"Value of the Usual Methods of Mechanical Testing of Plastics," D. J. van Wijk, *Plastica*, 8, 4, 188 and 8, 5, 242 (April-May, 1955).

After showing that the most important properties of plastics are time-dependent, the author considers the conditions required for the exact determination of these properties. The conventional mechanical tests (tensile, flex and impact strength, hardness, and heat distortion) are critically discussed, and it is concluded that they do not fullfill the stated conditions. Examples of other tests (creep, tension-relaxation, torsion-vibration) are given which yield reliable data on the behavior of plastics as a function of time. (In Dutch).

"Irradiated Organic Materials," S. T. Jones, *Canadian Plastics*, 32 (April 1955).

The changes in physical and chemical properties of organic materials resulting from absorption of radiation are discussed, with chemical reactions especially emphasized. Irradiation may discolor some materials, change the electrical properties, and induce degradation or polymerization in the polymers. Radiation processing is not expected to compete with conventional processes where it does not offer substantial advantages, but it is expected to prove most useful where it can be used in smaller amounts to achieve unusual results.

"Paper Chromatographic Studies on the Resinification of Phenol Alcohols." R. Reese, *Kunststoffe*, 45, 4, 137 (April, 1955).

A two-dimensional paper chromatographic technique was employed by which the primary reaction products of alkali and acid condensation of phenol-formaldehyde can be largely separated and identified. So far, only low-molecular products with about three phenol residues in the molecule have been identified, but it is thought that in the future higher molecular compounds will also be included. To explain the individual reactions, pure phenol alcohols were examined by paper chromatography under various reaction conditions. Possibilities for further extending the usefulness of the method are suggested, among others the use of different solvent mixes. Investigations still to be completed already indicate that a mixture of benzine, acetic acid and water used with the two-dimensional paper chromatography method improves identification, especially for the low-molecular intermediate products of Novolac formation. (In German).

"Isocyanate Foams." E. J. Mouton, *Plastica*, 8, 3, 126 (March, 1955).

The basic materials, their properties and chief applications and the process for producing isocyanate foams are discussed. A number of manufacturers of the foams in Europe and America, and the trade names under which they market their products, are listed. (In Dutch).

"Plasticized Polyvinyl Chloride." T. Paleologo, *Poliplasti*, 3, 7, 5 (Jan.-Feb. 1955) and 3, 8, 7 (March-April, 1955).

This is a comprehensive review of plasticized PVC covering the preparation and properties of the polymers and compounds, as well as the production of semi-finished and finished products for the most varied purposes. Foams, pastes, latices, lacquers, packaging materials, tubing, fittings, rainwear, upholstery, toys, etc., and various methods of finishing, including welding, sewing, printing, and coloring, are discussed. (In Italian).

EQUIPMENT

"Vibratory Conveyors in the Plastics Industry," H. Taubmann, *Kunststoffe*, 45, 5, 194, (May, 1955).

Vibratory conveyors are suitable chiefly for conveying bulk material with temperatures up to 600° C., as well as chemical products. The principle on which these devices work is explained, and the major types are described, including conveyors with gravity, electromagnetic, and eccentric drives, as well as a special spiral vibration design for vertical conveying. The possibilities for employing these conveyors in the plastics industry are mentioned. (In German).

"Automatic Temperature Control of Molding Tools for Processing Plastics," E. Staudner, *Kunststoffe* 45, 5, 213 (May 1955).

Special devices for automatic temperature control of molding tools are described which were designed in close collaboration with molders and, hence, are particularly well adapted to the special requirements of actual service. (In German).

"Adjustment and Control of Automatic Injection Molding Machines," H. Goller, *Kunststoffe*, 45, 5, 181 (May 1955).

The problems imposed by the many and diverse demands made on an injection molding machine, and how they can largely be met by adapting the various functions of the machine to the required processing conditions by appropriate adjustment and control systems, are discussed in detail. The greater versatility these systems confer, while increasing the safety of the operator, is stressed. Finally, brief mention is made of two new German machines designed for universal adjustment and control. (In German).

"The Ufix—Deepdrawing Machine for Thermoplastic Sheet," H. Behringer, *Kunststoffe*, 45, 5, 178 (May 1955).

With this device, pre-cut plastic disks are formed into round boxes by simultaneous drawing and compression between plunger and matrix. (In German).

"New Machines for the Vacuum Molding of Thermoplastics," E. Escales, *Kunststoffe*, 45, 5, 174 (May 1955)

The present article treats specifically of new machines by two German manufacturers, shown for the first time at the Hannover Fair held in April. One of these, 4500 mm. long by 1,500 mm. wide, is provided with an attached preheating chamber, and is equipped for both negative and positive molding. The infra-red heating element consists of two coupled units which can be separated so that, if necessary, the machine can be used as a twin-table machine with two working places. In the other machine, designed for smaller articles, the ceramic infra-red heating plates are swivel-mounted and separately connected so that either the left or right element or both can be used. After molding, the heating plates can be folded back to avoid heating up mold or machine. This model, too, has been designed for both negative and positive molding. (In German).

PROCESSING

"High Frequency Welding of Rigid PVC," L. Benker, *Plastverarbeiter*, 6, 5, 177 (May 1955).

The article deals with high frequency welding of straight seams on rigid PVC material 1-15 mm. thick. The necessary apparatus, precautions to be taken for successful welding, and the types of welds, are described. Possible defects and methods of detecting them are indicated. Experiments indicate possibilities for high-frequency welding of other plastics such as plasticized PVC, Astralon, Plexiglas and Ultramid. (In German)

APPLICATIONS

"Molded Plastic Bearings for Underground Mining Machinery," E. Jacob, *Plaste u. Kautschuk*, 2, 4, 86 (Apr. 1955).

Molded plastic bearings tested in compressed air motors and other mining machinery showed less wear than bronze or gray cast iron bearings. (In German.)

"Adhering Metals with Epoxy Resins," W. Schafer and H. John, *Plaste u. Kautschuk*, 2, 3, 52 and 2, 4, 84 (Mar. and Apr. 1955).

In 1954, several types of hot- and cold-hardening epoxy bonding resins were developed by the German Academy of Science, Berlin-Adlershof. Details are given of the production, properties, and applications of these resins in bonding metals. It is claimed that test results to date prove these new materials to be equal at least to similar foreign products so far as their main properties are concerned. Investigations are still being carried out on the strength of the adhesive bond achieved with metals, and the effects of metal surface treatment and type of joint on the bond. (In German.)

"'Ekazell-hart', A Plastic Material for Light Structures," A. Eckelmann, *Plaste u. Kautschuk*, 2, 4, 78 (Apr. 1955).

Ekazell, a foamed hard PVC with a specific gravity of 0.1-0.2, made by V.E.B. Elektrochemisches Kombinat, Bitterfeld, can be used for filling veneers, or can be combined on one or both sides with plastic or metal sheet. Described are methods of forming lightweight structures for various purposes. (In German.)

"Laying of Kawekan Pipe," W. Schrader, *Plaste u. Kautschuk*, 2, 4, 82 (Apr. 1955).

Kawekan pipe, for conveying potable water, was developed by V.E.B. Kabelwerk Kopenick on the basis of 20 years' experience in the production of PVC cable insulating compounds. The pipe consists of an extruded lining of PVC, reinforced with fabric or a metallic braid, and sheathed in plastic. The pipe comes in lengths of 150-200 meters and in various widths. Methods of laying the pipe and jointing with hard PVC are described. (In German.)

"An Important Application of Rigid PVC Tubing," M. Parducci, *Materie Plastiche*, 21, 4, 321 (Apr. 1955).

Details on the laying of rigid PVC piping for conveying potable water and carrying off waste water and sewage in a new housing project. La Resina di Arco, Trento, which is supplying the material, has patented, a "cup-type" joint system for connecting lengths of piping during installation. (In Italian.)

"Recent Applications of Plastics in Agriculture," N. B. Galluzzo, *Plastiques Informations*, 17 and 38 (Feb. 1 and Apr. 1, 1955).

Uses, in the United States, of acrylics, glass-reinforced plastics, and PVC sheet in farming and dairying, and for marketing agricultural products, are considered. There is also a picture of the part plastics could play in the future if it becomes necessary to "farm" the ocean. (In French.)

"Paints Based on Polyvinyl Acetate Emulsions," M. Tapin, *Plastiques Informations*, 12 (Apr. 1, 1955).

Paints based on polyvinyl acetate emulsions have certain advantages which are responsible for their increasing popularity in Britain, Germany and, more recently, in Belgium, as well as in the United States. Details are given on the paint constituents, methods of preparation and formulation, and representative formulations for specific types of paints. (In French.)

"Plastics in the Printing Industry." K. E. C. Buyn, *Plastica*, 8, 4, 180 and 8, 5, 236 (April-May, 1955).

A diagrammatic review of graphic reproduction techniques is followed by a description of the uses of various plastics for making negatives, matrix material, and printing plates. (In Dutch).

"Contribution of the Lacquer Industry to the Development of Processing Methods for Unsaturated Polyester Resins," W. Wittke, *Kunststoff-Rundschau*, 2, 5, 153, (May 1955).

The development of processing methods for unsaturated polyester resins requires collaboration with the lacquer industry which, on the basis of past experience and new insights, can help to solve problems in producing objects with satisfactory finish. This is illustrated by detailed descriptions of recent methods employed in making polyester resin advertising signs, a bathtub for medical treatments, and an automobile body. (In German).

"Epoxy Resin Molds for Three Dimensional Effect," Walter Bertucci, *Plastics World*, 13, 6, 6 (June 1955).

An illustrated description of how and why Epon, Shell's epoxy resin was chosen to form the molds for the Howdy Doody Mobile, a set of seven toys which met with considerable success at the recent Toy Fair.

"Glass Fiber-Reinforced Plastics," J. Duffos, *Industrie Plastiques Modernes*, 7, 7, 31 (July-Aug. 1955).

Applications for fibrous glass-reinforced plastics are described, with suggestions for the technologist as to fabricating techniques. The results of various tests are reported which show thread resistance to vary with the percentage of resin and molding pressure. Above and below the optimum values (1.5 kg/cm^2 pressure, 35% polyester and 30% special phenolic content) resistance decreases. The resin is reported to act merely as a binder, transmitting stress from fiber to fiber. (In French).

"Where and How to Use Epoxies," Jerome Formo and Luther Bolstad, *Modern Plastics*, 32, 11, 99 (July 1955).

Applications of these resins in adhesives, castings, moldings, and foams are considered in some detail. Eight property and formulation tables are included.

"Packaging Food Products," Stuart Simpson, *Canad. Plastics*, 28 (May 1955).

The three main groups of agricultural products are grown products (including fresh and dried vegetables and fruits, pickles, and the like), processed produce such as cheese, and animal products (meats and poultry). How the five classes of plastic film in use are employed to meet the packaging requirements of these products is the subject of this article.

"The Application of Plastics by the Flame-Spraying Method." R. Kuhfuss, *Poliplasti*, 3, 8, 3, (March-April, 1955).

Of the half-dozen classes of plastics that can be flame-sprayed, only the polyamides anl polyethylene are considered. The advantages and disadvantages of various designs of apparatus are briefly mentioned, and method costs and application are discussed. (In Italian).

"Isocyanates in the Paint and Varnish Industries." E. J. Mouton, *Plastica*, 8, 5, 232, (May 1955).

The raw materials, their properties and applications, and the processing methods used in making polyurethane-based lacquers, are reviewed. While the products have many excellent properties, they are dangerous to use and precautions must be taken. Finally, mention is also made of the use of urethane oils as binders for paints. (In Dutch).

"Present Status and Possibilities of Synthetic Resins for Varnishes," S. Medina-Castellanos, *Rev. Plasticos*, 6, 32, 102 (March-April, 1955).

A discussion of the mechanism of film-forming in synthetic resins is followed by a review of eight classes of condensation and two classes of polymerization products used in making varnishes. Under the individual heads, mention is made of a number of commercial products, chiefly of German origin. (Spanish).

GENERAL

"Decimal Classification of the Industry of Macromolecular Substances — Rubber Industry, Plastics Industry," M. Schuchmann, *Kunststoffe*, 45, 6, 229 (June 1955).

This is the official, abbreviated form of the new classification, the Industry of Macromolecular Substances, as decided by the International Documentation Federation. (In German).

"Accident Prevention on Injection Molding Machines," (Anon.), *Kunststoffe*, 45, 6, 254 (June 1955).

The type of accident, proposed regulations to prevent accidents, and examples of constructive measures by various machinery manufacturers are described in this article. Data are based primarily on an article by H. Schmidt, Guild for Fine Mechanics and Electrotechnics, Cologne, Germany. It was first published in "Die Berufsgenossenschaft," 10, 11, 1954. (In German).

"Toxicological Study of Plastic Films and Protective Lacquers for Packaging Foodstuffs," R. Lefaux, *Plastiques Informations*, 21 and 29 (Apr. 1 and May 16, 1955).

After considering the toxicity of materials used in the plastics and paint industries and mentioning the hygienic precautions to be taken to prevent skin and respiratory afflictions, the author discusses chronic toxicity caused by various plasticizers and stabilizers used in making food packaging films and coatings. (In French.)

"Patents for Softeners and Gelation Agents for Thermoplastics, since 1938," G. Tewes, *Kunststoff-Rundschau*, 2, 5, 163 (May 1955).

This is the first part of a review of patents taken out in various countries since 1938. The chemical composition of each product is given and applications are indicated by abbreviations separately explained. (In German).

"Further Chemical Developments in the Field of Plastics," K. Stoeckhert, *Gummi u. Asbest*, 8, 5, 250 and 8, 6, 318 (May & June 1955).

Recent research and development are reviewed on new methods of polymerization, new unsaturated polyesters, new softeners, developments in synthetic rubber, synthetic fibers, and plastic varnishes. (In German).

"Progress Report for 1954 of the Plastics Standardization Section (FNK) of the DNA," A. Hoechtlen and G. Ehlers, *Kunststoffe*, 45, 5, 187 (May, 1955).

Progress in developing standards for plastics since the publication of the 1953 Progress Report is detailed, and specification sheets and proposed standards issued since then are reviewed. (In German).

Patent Digest

Materials

Adhesive Composition for Bonding Polyperfluorovinyl Chloride to Metal. No. 2,710,821. William K. Fischer, Woodbury, Conn. (to United States Rubber Co., New York, N. Y.).

The composition comprises maleic anhydride-modified butadiene-acrylonitrile copolymer, obtained by heating with an inhibitor to prevent cross-linking. Polychloroprene and dehydroabietic acid dissolved in a mutual volatile organic solvent are added, and the solvent removed from between the film and the metal by heating.

New Polymeric Reaction Products of Mixed Polymethyl Benzenes. No. 2,712,532. Michael Mojzesz Szwarc, Syracuse, N. Y., and Alec Norman Roper, Manchester, England (to Petrocarbon, Ltd., London, England).

A pyrolyzed vapor mixture of at least two polymethyl benzenes is polymerized to form a solid resinous material which is characterized by high thermal stability, good insulating properties, and moldability.

Synthetic Resins from Hydrocarbon Pyrolysis Products. No. 2,712,538. Francis T. Wadsworth, Dickinson, Tex. (to Pan American Refining Corp., Texas City, Tex.).

Hydrocarbon gas is subjected to pyrolysis at a temperature above 1,300° F. The resulting gasiform stream is compressed to a pressure above 350 psi., and the condensable hydrocarbons are absorbed in a light absorption oil. This solution is distilled, leaving a highly unsaturated residue which then is polymerized in the presence of 0.5-5% boron trifluoride.

Polymerization of Ethylene with Ozonide Catalysts. No. 2,713,044. Richard E. McArthur and James S. Logan, Niagara Falls, N. Y. (to Olin Mathieson Chemical Corp., New York, N. Y.).

Solid homopolymers of ethylene are prepared, under suitable conditions of pressure and temperature, in a high pressure reaction vessel containing a small, catalytic amount of an ozonide of an ethylenically unsaturated organic compound.

Chelating Agents. No. 2,712,544. Frederick C. Bersworth, Verona, N. J. (to Dow Chemical Co., Midland, Mich.).

The general formula for certain type epoxide compounds containing low molecular weight alkylene groups is given in this patent.

Compositions Comprising a Polymer of Acrylamide and an Amide. No. 2,713,041. Henry Z. Friedlander, Greenwich, and William A. Barber, Stamford, Conn. (to American Cyanamid Co., New York, N. Y.).

The polymer contains at least 75% by weight of combined acrylamide, and at least one amide selected from the class consisting of urea and formamide; the urea being in the molten state when used.

Modified Alkyd Resins and Process of Preparing Same. No. 2,713,039. Leonard E. Cadwell, Stamford, and John C. Petropoulos, South Norwalk, Conn. (to American Cyanamid Co., New York, N. Y.).

The process comprises co-reacting styrene, ring-substituted alkyl-styrene, or ring-substituted chloro-styrene with an unsaturated oil-modified alkyd resin at a temperature of 160-175° C. A mutually inert solvent having a boiling point above 110° C., and a tertiary alkyl-substituted peroxide catalyst are used.

Filled Plastisol Compositions and Method of Making Same. No. 2,713,563. Leroy B. Kuhn, Douglassville, Pa. (to Firestone Tire & Rubber Co., Akron, O.).

A mixture of vinyl chloride and other ethylenically-unsaturated compounds is polymerized in aqueous emulsion in the presence of 0.03-0.08% emulsifying agents to prevent coagulation upon the addition of a solid, inorganic filler. This mixture is spray-dried at temperatures which will fuse the resin particles and produce a granular-filled vinyl chloride product adaptable for plastisol uses.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Phenolic Resins. No. 2,715,114. Rodney M. Huck, Longmeadow, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

A fusible phenolic resin is obtained by reacting one mol of monohydric phenol with 0.75-0.85 mol of a furfural- or aliphatic-saturated, unsubstituted aldehyde at a pH of 8-11, and at a temperature of 90-110° C., for 15-30 minutes. The mixture is then cooled, and the pH of the reaction medium adjusted to 1-3. The condensation reaction is completed by heating to 60-110° C., and dehydrating the reaction product.

Colloidal Asphalt Fillers for Plastics. No. 2,714,584. Ferdinand Kuster, Borgholzhausen, Germany.

A filler of asphaltic bitumen is admixed with a PVC or polyvinylidene chloride resin in the proportion of 2-50 parts by weight per 100 parts resin. Particle size for the filler should be between one micron and one millimicron to produce a plastic molding compound characterized by high insulation resistance, high tensile strength, and high resistance to cold flow.

Compositions Containing Glycidyl Polyether and a Polyvinyl Acetal Resin. No. 2,713,567. James R. Scheibli, San Lorenzo, Calif. (to Shell Development Co., Emeryville, Calif.).

The composition consists of a homogenous mixture of a glycidyl polyether of a polyhydric phenol having a 1,2-epoxy equivalency greater than 1.0, and a polyvinyl acetal resin.

Equipment

Molding Apparatus. No. 2,713,184. Edward Garabedian, East Providence, R. I.

The mold, which rests freely on a horizontal surface and against a generally vertical wall, comprises a pair of mold parts, a pressure member, a means for pivotally mounting this pressure member on the horizontal support, and a means for swinging it against the paired mold parts during the mold-pouring operation.

Apparatus for Laminating Plastics. No. 2,713,378. Max A. Nadler, Compton, and Robert E. Medick, Inglewood, Calif. (to North American Aviation, Inc., Los Angeles, Calif.).

The apparatus has a hard, unyielding surface opposite a sheet of rough-weave material to which a release agent is applied, a plurality of stiff porous pads, and an elastic membrane covering the pads. A vacuum line situated above the rough-weave material makes the membrane air-tight.

Apparatus for Molding Plastic Materials. No. 2,714,226. Irving R. Axelrad, Pittsburgh, Pa. (to Westinghouse Electric Corp., East Pittsburgh, Pa.).

The relatively rigid metal base of the apparatus has a face and a recess for fitting a mold of elastomeric material. A cooling means is associated with the base, and a heated injection unit forces the heated plastic material into the mold cavity under pressure. The walls of the mold are sufficiently strong to withstand the pressures without distortion.

Extrusion Press. No. 2,713,418. Francis J. Kent, Forest Hills, N. Y. (to Hydropress, Inc., New York, N. Y.).

An extrusion press, for extruding long billets of large cross-section and shorter billets of smaller cross-section, has a billet container with a longitudinally-extending bore for receiving the short billets, and a counter bore to provide a recess of increased diameter which opens at one side of the billet container. The counter bore receives an extrusion root stem of larger diameter, and an elongated block guides the larger billet into said bore.

Wet Polymer Extruder. No. 2,713,698. Spencer Danby, Jr., James H. Ellett, Algernon P. Guess, and Thurman V. Williams, Jr., Camden, S. C. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The extruder has a die plate and an auger shaft with a plurality of rotating wiper blades at its extrusion end. These blades are covered with a water-repellent, resilient polymeric material so that they conform to the contour of the die plate throughout the wiping operation.

Molding Machine. No. 2,713,697. Thomas N. Willcox, Pittsfield, Mass. (to General Electric Co., Schenectady, N. Y.).

This molding machine for thermosetting materials has a means for holding a plurality of preforms in a vertical stack. The high-frequency preheating chamber has walls and floor of electrically conductive material. A pneumatically-operated pusher engages the lowermost preform and slides it across into the preheating chamber for a predetermined interval. A second pneumatically-operated pusher transfers the preform to the mold, and a heated hydraulic ram applies pressure to form the desired part. An ejection means removes the part.

Processing

Process for Bonding a Polyethylene Film to a Fibrous Web. No. 2,714,571. Clarence E. Irion, North Pownal, Vt., and Karl E. Prindle, Shaker Heights, O. (to The Dobeckmun Co., Cleveland, O.).

A film of molten polyethylene is extruded onto a fibrous web as both pass simultaneously through rollers. The film is then cooled to a temperature at which it is no longer tacky, removed from the roll, and reheated to at least 225° F. Upon recooling, a strong bond is established between the film and the web.

Method of Joining Plastic and Metal. No. 2,714,746. Arthur A. Meyer, Beloit, Wis. (to Warner Electric Brake & Clutch Co., South Beloit, Ill.).

A metal part is joined to a plastic part which is brittle when set by molding the plastic around the metal under heat and pressure, and compressing both to compensate for differential shrinkage during cooling.

Process for Treating Polyethylene Structures. No. 2,715,077. Leon E. Wolinski, Buffalo, N. Y. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Polyethylene film is subjected to the action of a gaseous atmosphere containing at least 5% by volume of nitrous oxide at a temperature within the range of 150° C. and the point of degradation of the polymer itself. Sufficient time is allowed to render the film's surface adherent to printing ink.

Process for Treating Polyethylene Structures and Articles Resulting Therefrom. No. 2,715,076. Leon E. Wolinski, Buffalo, N. Y. (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Polyethylene film is subjected to a gaseous atmosphere containing at least 0.01% by volume of ozone and 0.01% by volume of nitrous oxide at a temperature sufficient to render the film adherent to printing ink, but below the degradation point of the polymer.

Process for Treating Polyethylene Structures and Articles Resulting Therefrom. No. 2,715,075. Leon E. Wolinski, Buffalo, N. Y. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The surface of the polyethylene film is subjected to a gaseous atmosphere containing at least 0.01% by volume of ozone and a gaseous halogen accelerator. Sufficient heat is applied to render the surface adherent to printing ink, being careful not to reach the degradation temperature of polyethylene.

Method of Sealing the End of a Thermoplastic Tube. No. 2,715,087. George Barradas, North Tarrytown, N. Y. (to PM Industries, Inc., Stamford, Conn.).

A heating element is inserted within the marginal and sealing areas of the tube, heated to soften the interior surfaces, withdrawn, and the heated marginal surfaces compressed to form a permanent closure.

Method of Coating Paper with Thermoplastic Resins. No. 2,715,088. John Robert Gunning, Georgetown, Ont., Canada (to Provincial Paper, Ltd., Toronto, Ont.).

The resin is heated to plasticity and extruded in a plurality of thin, closely-spaced parallel filaments onto the surface of the paper. The filaments are then fused into a continuous film, and bonded under pressure.

Process for Impregnating Cellulosic Material with Thermosetting Resin. No. 2,715,078. Oscar P. Cohen, Watertown, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

Cellulosic textile material is immersed in an aqueous solution of a cationic surface-active agent at a temperature of 100-200° F., permitting virtually all of the agent to migrate onto the material. It is then immersed in an aqueous solution of unpolymerized urea-formaldehyde or alkylated urea- or melamine-formaldehyde for an hour at a temperature of 115-118° F. The material is then extracted, dried, and heated to insolubilize the condensation product.

Applications

Fabrication of Pipe from Glass Fiber and Plastic Material. No. 2,714,414. Carl De Ganahl, Greenlawn, N. Y., John A. Grant, Granville, and Clare E. Bacon, Newark, O. (to Owens-Corning Fiberglas Corp., Toledo, O.).

Helical layers of glass thread coated with fluid plastic material are continuously applied on an upwardly-advancing mandrel. The plastic is then cured and the mandrel removed.

Reinforced Covering for Pipes. No. 2,713,551. Ted Kennedy, Ann Arbor, Mich. (to The Trenton Corp., Ann Arbor, Mich.).

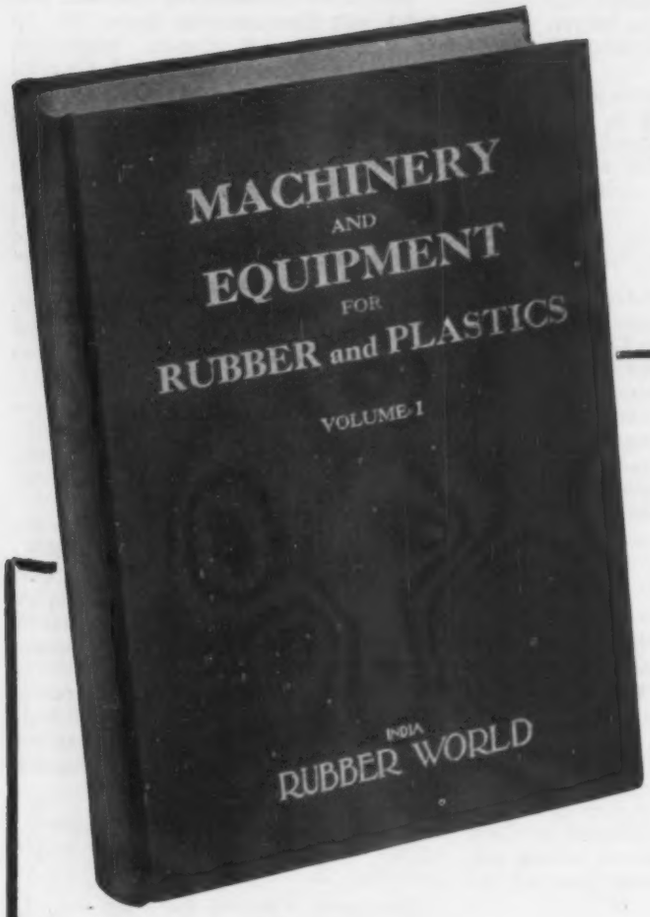
A reinforced plastic strip for covering pipe comprises a first lamination of flexible polyethylene film, a second lamination of flexible glass fibers, and a third lamination of asbestos felt which is impregnated with emulsified wax for waterproofing.

Thermoplastic Container. No. 2,713,369. Andre Strahm, Vevey, Switzerland (to Uni-Tubo S. A., Vevey, Switzerland).

The head portion is integrally fused to the tubular body portion by means of a narrow, stepped, overlapping marginal area. This joint area comprises a continuous circumferential, downwardly-extending portion, and the narrow marginal band of the body wall extends partially over the top surface of the head portion.

Die Cast Plastic Keys and the Method of Forming the Same. No. 2,714,949. Louis H. Morin, Bronx, N. Y.

A molded, two-color plastic key comprises a body with reduced, hollow mounting end. An integral portion protrudes from the opposite end, and a one-piece shell envelopes the body with the exception of part of the mounting end and the outer surface. A hook flange engages the body and prevents displacement of the shell.



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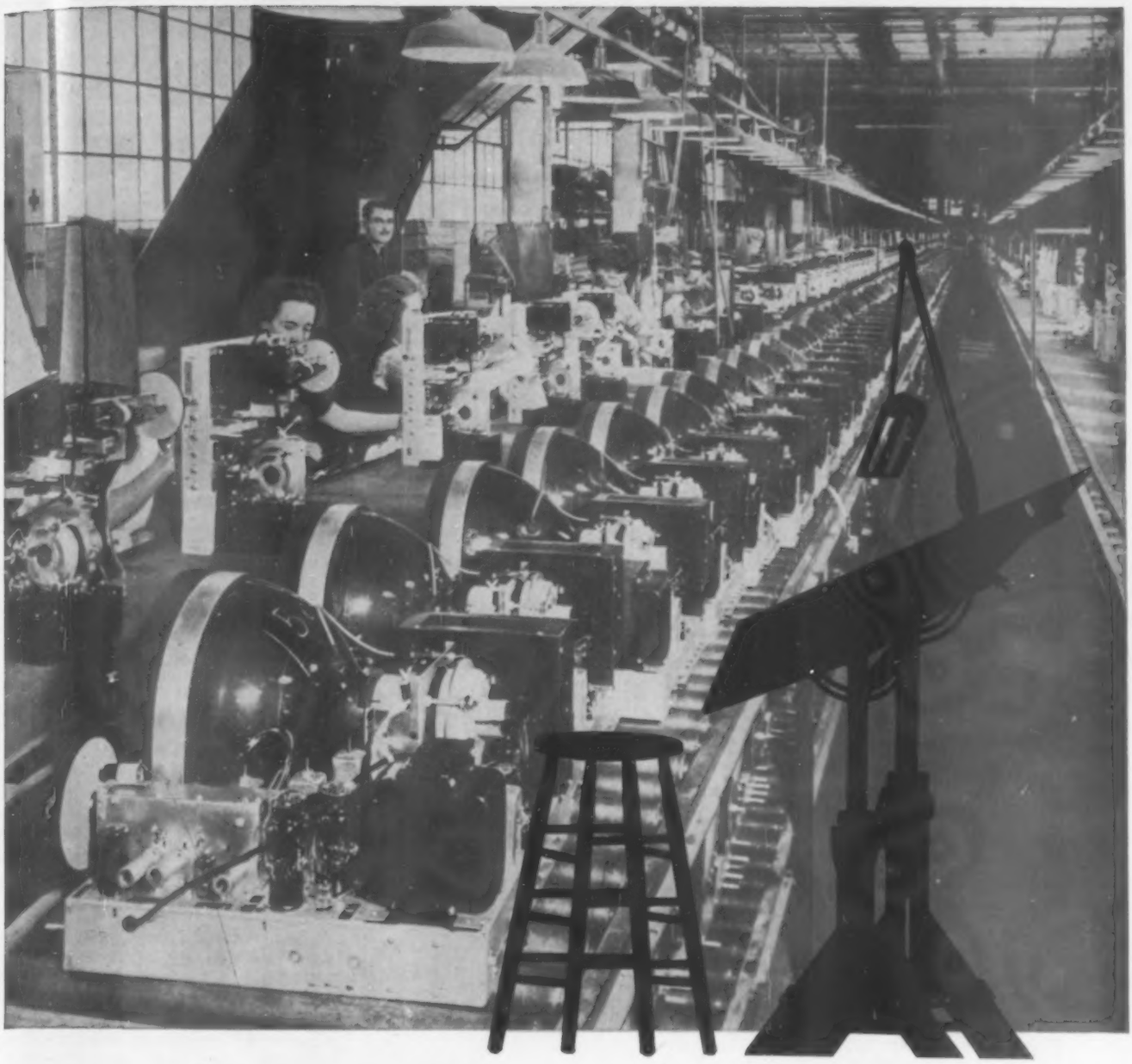

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Domestic Production and Sales of Plastics and Resin Material, March and April, 1955

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of March and April, 1955. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

With the exception of polyesters and miscellaneous materials, production and sales showed a slight decrease. This was probably due to the anticipated summer decline.

	March		April	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	2,096,467	1,911,420	1,398,906	1,452,743
Sheets, 0.003 gage and over	1,418,896	1,428,079	1,243,176	1,108,227
All other sheets, rods, and tubes	765,440	690,386	623,169	567,009
Molding and extrusion materials	7,422,246	7,046,427	7,574,476	7,406,053
Nitrocellulose sheets, rods, and tubes	483,053	523,238	427,180	433,764
Other cellulose plastics	743,534	597,003	584,278	478,399
TOTAL	12,929,636	12,196,553	11,851,185	11,446,195
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	19,287,162	17,717,015	18,876,464	16,372,342
Bonding and adhesive resins for—				
Laminating (except plywood)	5,841,494	3,979,687	5,159,155	3,820,505
Coated and bonded abrasives	1,226,943	1,330,063	1,204,860	1,262,860
Friction materials (brake linings, clutch facings, and similar materials)	2,418,310	1,913,971	2,188,320	1,958,151
Thermal insulation (fiber glass, rock wool)	3,545,871	3,719,919	3,624,480	3,667,114
Plywood	3,810,570	3,099,351	3,672,430	2,975,713
All other bonding and adhesive uses	1,274,345	1,295,715	1,352,704	1,320,364
Protective-coating resins, unmodified and modified except by rosin	2,597,956	2,197,794	2,568,338	2,291,343
Resins for all other uses	4,054,342	3,511,882	3,370,039	3,270,370
TOTAL	44,056,993	38,765,397	42,016,790	36,938,762
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	4,189,000	3,875,122	3,496,609	3,443,276
Paper-treating and paper-coating resins	2,088,310	1,928,700	1,958,882	2,038,283
Bonding and adhesive resins for—				
Plywood	8,856,800	8,337,475	7,741,433	7,583,765
All other bonding and adhesive uses, including laminating	2,506,593	2,823,592	3,058,263	2,579,109
Protective-coating resins, straight and modified	3,176,397	2,454,317	3,086,175	2,317,829
Resins for all other uses, including molding	7,315,525	7,431,107	7,455,711	6,767,495
TOTAL	28,132,625	26,850,313	26,797,073	24,729,757
Styrene Resins:				
Molding materials[1]	37,130,688	35,745,732	34,996,616	33,857,545
Protective-coating resins, straight and modified	8,324,930	8,381,410	8,304,109	8,469,020
Resins for all other uses	7,054,044	6,963,112	6,827,738	7,424,837
TOTAL	52,509,662	51,090,254	50,128,463	49,751,402
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more polyvinyl chloride) for—				
Film (resin content)		8,052,321		8,227,049
Sheeting (resin content)		4,429,234		4,709,243
Molding and extrusion (resin content)		16,101,543		15,568,118
Textile and paper treating and coating (resin content)[3]		5,401,896		5,779,100
Flooring (resin content)		5,208,125		5,134,130
Protective coatings (resin content)		2,815,044		2,601,266
All other uses (resin content)		4,336,326		3,271,231
All other vinyl resins for—				
Adhesives (resin content)		2,858,828		2,585,550
All other uses (resin content)		8,864,839		8,966,812
TOTAL	59,767,437	58,068,156	56,773,223	56,842,499
Coumarone-Indene and Petroleum Polymer Resins	22,773,691	23,259,908	22,533,226	23,011,097
Polyester Resins:				
For reinforced plastics	5,032,624	3,890,845	4,743,027	4,015,387
For all other uses	166,981	262,232	168,590	195,358
TOTAL	5,199,605	4,153,077	4,911,617	4,210,745
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1] [4]	25,674,557	19,294,858	28,435,753	19,642,107
Protective-coating resins[5]	338,668	218,546	408,057	248,117
Resins for all other uses[6]	11,384,360	17,947,225	12,473,380	18,514,656
TOTAL	37,397,585	37,460,629	41,317,190	38,404,880
GRAND TOTALS	262,767,234	251,844,287	256,328,767	245,335,337

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, polyethylene, nylon, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.

SOURCE: United States Tariff Commission, Chemical Division.

Monsanto Chemical Co.'s organic chemicals division, St. Louis, Mo., has announced the commercial availability of HB-40, an extender-type plasticizer for use with vinyl plastisols, tiles, and filled extrusions.

Durez Plastics division of Hooker Electrochemical Co. has moved its Chicago branch office from 221 N. LaSalle St. to 1 N. LaSalle St., thus joining the parent company at the same address.

The Visking Corp., Terre Haute, Ind., has announced that its suit against Durethene Corp. for patent infringement in the production of polyethylene film has been settled, with Durethene being granted a non-exclusive license under Visking's patents 2,461,975, 2,461,976, and 2,632,206.

Monsanto Chemical Co., St. Louis, Mo., has announced that an interim plant for the production of a high-density boilable polyethylene will be in operation by the end of summer at the Texas City, Texas, plant.

The Tyson Corp., Woodbridge, N. J., has been appointed sales agent for C. P. Hall Co., Los Angeles, Calif., products east of the Rocky Mountains. Hall manufactures rubber substitutes from vulcanized vegetable oils, plasticizers, and fillers.

Atlantic Foam Products Co., Ipswich, Mass., has been named a distributor for Styrofoam in the New England area by Dow Chemical Co., Midland, Mich., manufacturers of the expanded polystyrene. Atlantic maintains warehouse facilities in Ipswich and Salem, Mass.

Reichhold Chemicals, Inc., White Plains, N. Y., offers two experimental polyesters to selected manufacturers for evaluation in the manufacture of polyurethane foams. One resin is intended for use with flexible foams, and the other for rigid foams. Inquiries should be directed to D. G. Patterson, of the company's Polyester Resin Division, 525 North Broadway, White Plains, N. Y.

Naugatuck Chemical Division, United States Rubber Co., New York, N. Y. announces that its Marvinol VR-22 vinyl resin has been approved by Underwriters' Laboratories, Inc. for electrical applications. Intended for extrusion from dryblend or granular compounds, the material can be used interchangeably in many approved wire insulating formulations based on straight PVC.

Current Market Prices

Price Changes and Additions

Molding Compounds & Resins

Acrylic

Cadco cast rods	lb.	1.42 /	6.96
Polished	lb.	1.58 /	7.16

Phenolic

Rogers RX-425	lb.	.285 /	.35
-428	lb.	.345 /	.42
-429	lb.	.355 /	.425
-431	lb.	.4125/	.495
-438	lb.	.4575/	.4625
-442	lb.	.3375/	.3425
-447	lb.	.495 /	.50
-448	lb.	.345 /	.35
-458	lb.	.37 /	.375
-469	lb.	.355 /	.36
-525	lb.	.285 /	.29
-530	lb.	.4125/	.4175
-625	lb.	.385 /	.39

Polyester

Laminac 4120	lb.	.39 /	.405

Styrenes

Cycolac, natural powder	lb.	.58 /	.66
Pellets, nat. & std. colors	lb.	.65 /	.73

Vinyls

Geon 101, 101EP, 103EP, 202	lb.	.31 /	.49
121	lb.	.34 /	.52
126	lb.	.32 /	.50
200X20	lb.	.37 /	.55
205, 400X65, 400X74L, 400X78	lb.	.35 /	.53
400X80	lb.	.45 /	.63
400X110	lb.	.42 /	.60
404HI	lb.	.40 /	.58
2042, 2046	lb.	.335 /	.57
2042, colors	lb.	.385 /	.62
6373, 8372	lb.	.365 /	.60
Colors	lb.	.415 /	.65
6461	lb.	.345 /	.58
Colors	lb.	.395 /	.63
8539	lb.	.35 /	.585
Colors	lb.	.37 /	.605
8600, 8620	lb.	.295 /	.53
Colors	lb.	.345 /	.58
8630	lb.	.445 /	.68
Colors	lb.	.495 /	.73
8640	lb.	.37 /	.605
8650	lb.	.33 /	.565
8656	lb.	.38 /	.615
8677	lb.	.455 /	.69
8700A, 8750	lb.	.455 /	.69
Colors	lb.	.485 /	.72
8720	lb.	.625 /	.86
8726, 8737	lb.	.35 /	.585
8740	lb.	.315 /	.55
8749	lb.	.31 /	.545
8800	lb.	.55 /	.785
8801	lb.	.295 /	.53
Colors	lb.	.345 /	.58
8802	lb.	.35 /	.585
Colors	lb.	.40 /	.635
8804	lb.	.30 /	.535
8807	lb.	.45 /	.685
8809	lb.	.39 /	.625
8812, 8813, 8814, 8815	lb.	.345 /	.58
Latex 151, 251	lb.	.29 /	.75
351	lb.	.34 /	.75
352	lb.	.31 /	.75
552	lb.	.39 /	.75
576	lb.	.36 /	.75
652	lb.	.37 /	.75
Polyblend	lb.	.445 /	.545
Marvinols, VR series	lb.	.31 /	.53

Plasticizers

KP-90	lb.	.40 /	.43
Ohio-Apex diisobutyl adipate	lb.	.4325/	.4625

American Wheelabrator & Equipment Corp., Mishawaka, Ind., has announced a change in corporate name to Wheelabrator Corp. The move does not involve any alteration in ownership, management, or company operation.

Plax Corp., originators of the plastic bottle, and producers of polystyrene and methacrylate sheet, has relocated its New York City and Chicago offices to 500 Fifth Ave. and 1607 Howard St., respectively.

The American Society of Tool Engineers has increased its membership in the United States and Canada to over 31,000 with the presentation of charters to the Monadnock chapter, Keene, N. H., and to the Oklahoma City chapter.

The Plastics Institute, London, England, has announced a change of address from Adelphi, Adams St., to 6 Mandeville Place, London W.1.

Rhodia, Inc., New York, N. Y., has appointed Naugatuck Chemical Division of Dominion Rubber Co., Ltd., as Canadian sales and technical representative for its industrial reodorants and aromatic chemicals.

Riverdale Plastic & Chemical Corp., Culver City, Calif., has been named West Coast sales representative for Poly-Eth polyethylene, a product of Spencer Chemical Co., Kansas City, Mo. Riverdale will also have the services of West Coast Plastics Distributors, Los Angeles, Calif., marketers of machinery and equipment to the plastics industry.

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CALENDAR of COMING EVENTS

September 6
SPE Southern California Section, Scully's Restaurant, Los Angeles, Calif.

September 14
SPE Newark Section, Military Park Hotel, Newark, N. J.

September 21
SPE New York Section, Gotham Hotel, New York City.

September 28
Reinforced Plastics Group, SPE New York Section, Tufaro's Restaurant, Corona, N. Y.

September 29
Fort Wayne Rubber & Plastics Group, Van Orman Hotel, Fort Wayne, Ind.

October 13, 14
SPI New England Section, Equinox House, Manchester, Vt.

November 14-15
TAPPI National Plastics Meeting, Brooklyn, N. Y.

November 16
SPE New York Section, One-day symposium, "Plastics for Packaging"

December 6, 7
SPI Film, Sheeting, and Coated Fabrics Divisional Conference, Hotel Commodore, New York, N. Y.

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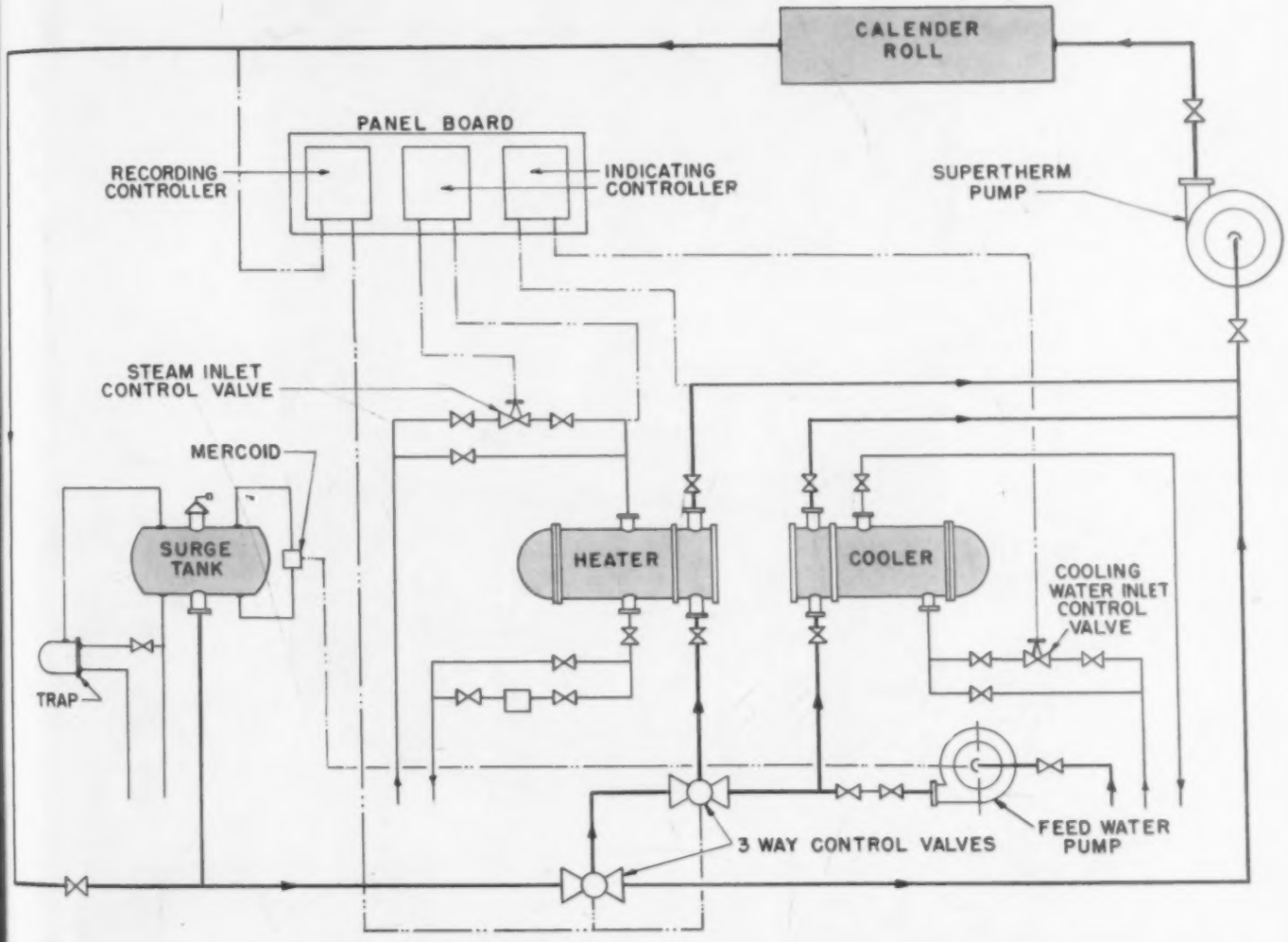

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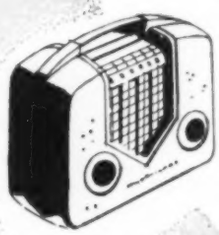

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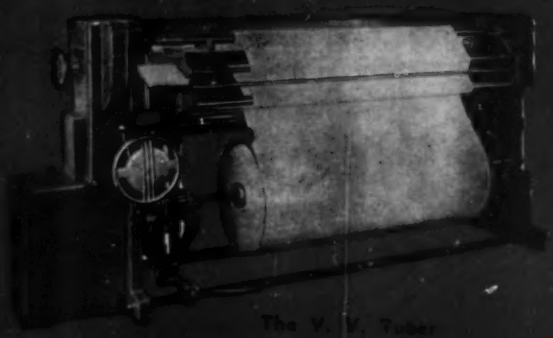

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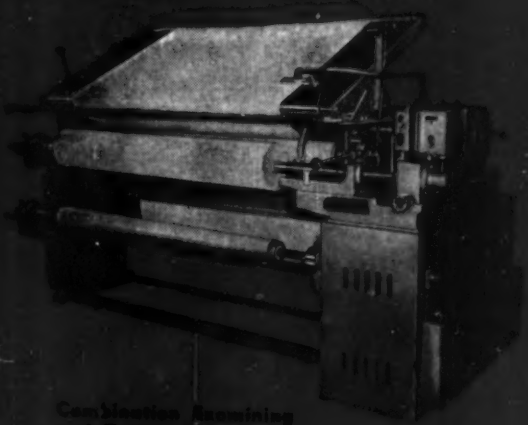

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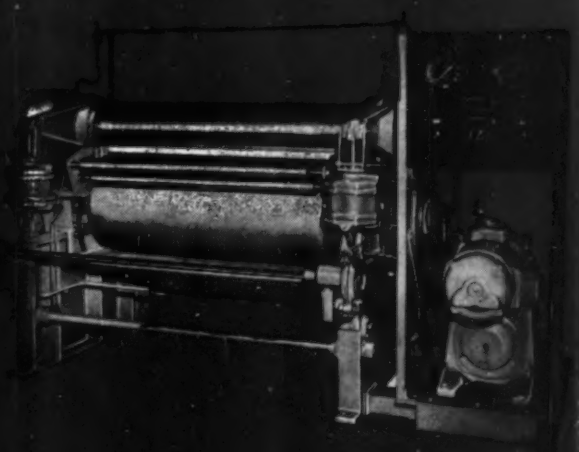

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